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EUNICE ROCKWOOD OBERLY

1878–1921

NEIL E. STEVENS[1]

WITH PORTRAIT. WITH PLATE II

"The librarian who builds up the collection for a research institution, and in connection with it, administers an effective bibliographical service, is making a fundamental contribution to the research work of that institution, too important to be underestimated or forgotten, merely because he may not find time to publish catalogs or bibliographies." These words, inserted as an afterthought in the paper read before the June 1921 meeting of the American Library Association by Miss Eunice R. Oberly express with characteristic brevity and directness Miss Oberly's appraisal of library work. They also express the attitude of her associates, whether librarians or investigators, toward her own work. This feeling of appreciation has found concrete expression in the establishment of the prize to which reference has just been made. This prize is an especially appropriate memorial. Miss Oberly's best memorial, however, is her record of sound achievement and enthusiastic service, only a brief outline of which will be attempted here.

Eunice Rockwood Oberly was born on March 7, 1878, in Cairo, Illinois. Her father, John H. Oberly, was at the time editor of the "Cairo Bulletin." She was the youngest of seven daughters. Her family moved to Washington in 1885 (her father serving as Civil Service Commissioner and later as Commissioner of Indian Affairs in the Cleveland Administration) and it was here that Miss Oberly spent the greater part of her life. She was prepared for college in the public schools of Washington and at Concord, New Hampshire, her father being for a short time editor of the "Patriot," published in Concord. She was graduated from Vassar in June, 1900, being class historian. She came to the U. S. Department of Agriculture in the summer

[1] The preparation of a suitable biographical sketch of Miss Oberly's life has been unduly delayed for unavoidable reasons. It is felt that the awarding of the first prize in her name is an appropriate occasion for publishing such a sketch, which has just been made possible by Dr. Stevens.—Editor.

of her graduation from college and, after a few years of bibliographical work in the Bureau of Animal Industry, she was appointed librarian of the Division of Vegetable Physiology and Pathology. With the consolidation of the library of the Division of Vegetable Physiology and Pathology with the library of the Office of Botanical Investigations in 1908 to form the library of the Bureau of Plant Industry, she was made librarian of the bureau, which position she held at the time of her death. Her whole professional life was, therefore, spent in the U. S. Department of Agriculture.

The "Plant Industry Library" was and still is a library without books. It is essentially a library service for the purpose of indexing and cataloging botanical literature and making readily available to the workers in the Bureau of Plant Industry the literature in the libraries of Washington and elsewhere, especially, of course, the Library of the United States Department of Agriculture and the Library of Congress.

There is little opportunity in such a library to develop the attitude of a "curator" of books so often found in university librarians and so irritating to university investigators. Probably in any environment Miss Oberly's ideals and methods would not have been very different. Certainly in the library of the Bureau of Plant Industry her dominant idea was that the library should be of the greatest possible service to the investigators. In almost every one of her various statements of the aims and methods of her work occur, "Service is the watchword of the modern librarian," and "The book which any person may want when he wants it." How well these ends were attained in the administration of her own library is abundantly attested by the fact that the organization which she built up was regarded by botanical investigators in Washington as almost a model of its kind. Of the Bureau of Plant Industry Library, botanists in university centers always spoke with respect, often with envy. A few years ago the writer published in Science a note under the title "The Obligation of the Investigator to the Library." This brought a somewhat heated response from a professor of botany in one of our great universities, the general tenor of which was that not all libraries lived up to the ideals which the writer had taken for granted. This letter concluded "Your library is one of the striking examples of subordination of library autonomy to the researchers."

As was natural, in view of the large amount of work in the study of plant diseases carried on in the Bureau of Plant Industry, Miss Oberly's special contributions to bibliography were on the subject of phytopathology. The list of literature on plant diseases printed in "Phytopathology" from June, 1914, to December, 1920, was begun by her, although afterwards carried on by members of her staff. Another example of her cooperation with the activities of the Department was the work of her library in editing and standardizing the bibliographies in the Bureau of Plant Industry pub-

lications and in the "Journal of Agricultural Research." Her knowledge of the relations and organization of phytopathological literature was probably unique, and the card catalog on this subject which she initiated became of great service. Its wide use and appreciation by the Bureau of Plant Industry pathologists prove its merit. The "Check List of Publications of the Department of Agriculture on the subject of Plant Pathology, 1837–1918," which was issued in 1919 as No. 1 of the Bibliographical Contributions of the Department of Agriculture Library, was prepared by Miss Oberly, although her name does not appear on it. The "Check List of Publications of the State Agricultural Experiment Stations on the subject of Plant Pathology," issued as Bibliographical Contribution No. 2, was begun by her but was completed after her death by her assistant, Miss Jessie M. Allen. Two bibliographical articles which she prepared in the summer of 1921 were also published after her death, namely, "The Contributions of Librarians to Agricultural History and Research," which appeared in the "Library Journal" for March 15, 1922, and an article on "Abstracts and Titles of Scientific Articles from the Librarian's Standpoint," published in "Science" for November 18, 1921. Both of these articles show her deep interest in scientific bibliography.

It was Miss Oberly's conviction that it would be of great advantage both to investigators and librarians if there could be developed, in some way, greater cooperation between them. At the time of her death she was at work on a plan whereby the librarians of research institutions might identify themselves with the scientific societies as well as with the library associations, and had even suggested the possibility of a bibliographical section in the American Association for the Advancement of Science.

Miss Oberly's interest was thus by no means confined to making her library of use to investigators in Washington. It was her ambition to make the combined library facilities of the country more readily available to the botanical investigators of this country and indeed of all countries. To this end she advocated a census of the library facilities of the country, which should be available to librarians and investigators alike.

The results of the cataloging and indexing of botanical literature carried on in the Bureau of Plant Industry were through her efforts made directly available to botanical workers outside of Washington in two ways. From 1914 to 1920 there was furnished for publication in "Phytopathology" a monthly list of literature relating to plant diseases. Later there was developed the circulation from the Bureau Library of a mimeographed list of botanical literature. This list, which is issued every two weeks, contains full citations of all important botanical literature received by Washington libraries. As a means of keeping investigators in constant touch with the new literature of their subject, this list has never been equalled. It proved

immensely popular; requests for it and letters of appreciation were received from botanists all over the United States, so that now more than two hundred and fifty copies are regularly sent to American investigators and institutions outside Washington. There is also a small foreign circulation, and Dr. E. J. Butler, Director of the Imperial Bureau of Mycology, in England, stated during his visit to this country in 1921 that this list of literature was the most useful thing that the Bureau received from the Department of Agriculture.

Of Eunice Oberly's rare qualities of mind and of her vivid and attractive personality it is unnecessary to write in a journal, a large number of whose readers were her friends. To readers who did not know her personally, any terms the writer might use would certainly seem extravagant. Ten years ago, when the writer entered the Bureau of Plant Industry, he was told by the head of an office that you could argue with Miss Oberly just as you would with a man. This was intended as a great compliment and apparently meant that opposition to her own opinion produced no irritation and that she showed extraordinary patience, tolerance, and fair mindedness toward the opinions of others. The resolutions adopted by the American Phytopathological Society at its first meeting after her death certainly expressed the feeling of the membership, as well as the committee, in referring to her as a colleague and friend, and acknowledging the debt of the society as an organization and the membership as individuals to her "kindliness, efficiency, and wide acquaintance with the literature of our subject." This wholly inadequate appreciation of Miss Oberly's work will probably be best concluded as it was begun by quotation from the paper written a few months before her death on "Contributions of Librarians to Agricultural History and Research," which gives in her own words the ideals to which her professional life was devoted.

"Hand in hand with the discovery and publication of new facts should go the constant development and perfection of our means for discovering the facts recorded in the mass of scientific literature already published. The necessity of division of labor here is obvious, though for the best results there must always be in this work the closest cooperation between librarian and research workers. The opportunities for agricultural research librarians and bibliographers to render service, at present, perhaps, undreamt of, are limited only by the appreciations of these possibilities on the part of research workers. The more encouragement librarians receive, the more eagerly will they undertake to qualify themselves to increase a hundredfold their efforts to mobilize and organize the literature of agriculture for the use of the research worker, thus conserving his time for original observation and experiment in the field and laboratory for which he is trained."

FIRST AWARD OF THE EUNICE ROCKWOOD OBERLY MEMORIAL PRIZE

NEIL E. STEVENS

Announcement of the first award of the Eunice Rockwood Oberly Memorial Prize was made the last of December, 1924, during the Washington meetings of the American Phytopathological Society. The prize was awarded to Mr. Max Meisel, formerly of the Science Division of the New York Public Library, for the first volume of his extensive bibliography on American natural history, published in the fall of 1924 by the Premier Publishing Company, 626 Broadway, Brooklyn, N. Y. Its scope is explained in the full title of the bibliography which is as follows: "A Bibliography of American Natural History: The Pioneer Century, 1769–1865; The role played by the Scientific Societies; Scientific Journals; Natural History Museums and Botanic Gardens; State Geological and Natural History Surveys; Federal Exploring Expeditions, in the rise and progress of American Botany, Geology, Mineralogy, Paleontology and Zoology." It is to be published in three volumes. The first volume contains 244 pages and is "an annotated bibliography of American natural history and its institutions, during colonial times and the pioneer century, which have been published up to 1924; with a classified subject and geographic index; and a bibliography of biographies." This bibliography will be a very useful reference tool and sets a high standard of comparison for material which may be submitted in competition for the Oberly Prize in the future.

The foundation of this prize in memory of Miss Oberly, formerly Librarian of the Bureau of Plant Industry of the U. S. Department of Agriculture, is the direct outcome of the spontaneous expression of regard by her associates at the time of her death. Her sudden death on November 5, 1921, after only a few days' illness was a great shock to her friends and co-workers. From all of them contributions for flowers poured in without solicitation until the amount was so large that it could not appropriately be spent on so perishable a memorial. Thus within a few hours of her death plans were started looking toward the establishment of a permanent memorial which would not only perpetuate her memory but also help in carrying forward the work in which she was so deeply interested.

From among friends in the U. S. Department of Agriculture who were closely associated with Miss Oberly in her work, a temporary committee was formed to handle the contributions and to decide on the form of the memorial. At first, contributions to the fund were received only from Miss

Oberly's associates in the Department of Agriculture, who gave about two-thirds of the first amount received. Later, contributions were received also from friends and library co-workers outside of the Department, from her college classmates and from the American Phytopathological Society. The amount of the contributions soon reached the goal of the temporary committee, which was $1,000, but it is hoped and expected that the amount may be increased from time to time.

In view of Miss Oberly's own bibliographical contributions and her appreciation of and belief in the possibilities of service inherent in bibliographical work, the committee unanimously decided to have the memorial take the form of a cash prize to the amount of the annual or biennial interest on the $1,000, to be awarded to the compiler of the best bibliography in the field of agriculture or the natural sciences. It was further decided to ask the American Library Association to administer the fund and to appoint a permanent committee with power and authority to formulate rules and conditions to govern the award of the prize and to select and designate the beneficiary.

The administration of the fund was definitely accepted by the American Library Association in December, 1922. The contributions to the fund were turned over to the American Library Association by the temporary committee on March 31, 1923. The President of the American Library Association then appointed the permanent Eunice Rockwood Oberly Memorial Fund Committee with the following membership: Claribel R. Barnett, Chairman, Librarian, U. S. Department of Agriculture, Washington, D. C.; William Warner Bishop, Librarian, University of Michigan, Ann Arbor, Michigan; Mary E. Hazeltine, Preceptor, University of Wisconsin Library School, Madison, Wisconsin; Mary G. Lacy, Librarian, Bureau of Agricultural Economics, Washington, D. C.; Edward D. Tweedell, Assistant Librarian, John Crerar Library, Chicago, Illinois; Mary K. Bryan and Erwin F. Smith, Bureau of Plant Industry, Washington, D. C.

CULTURAL AND MORPHOLOGICAL STUDIES OF SOME SPECIES OF TAPHRINA

ELLA MAY MARTIN

WITH TWO FIGURES IN THE TEXT

In connection with cytological studies of certain species of Taphrina, it appeared desirable to cultivate these forms artificially in order to determine the number and condition of the nuclei in the young mycelium. The forms used were the following: *Taphrina Johansonii* Sadebeck, *Taphrina communis* (Sadebeck) comb. nov. (*Exoascus communis* Sadebeck), *Taphrina mirabilis* (Atkinson) comb. nov. (*Exoascus mirabilis* Atkinson), *Taphrina coryli* Nishida, *Taphrina deformans* Tulasne, and *Taphrina coerulescens* (Mont. et Desm.) Tul. The nomenclature used for the second and third forms is explained by the writer (4) and in brief is as follows: All species studied should be placed in the genus Taphrina if we adhere to the rule of priority, for Taphrina was the generic name given by Fries, 1827. Later writers have used the generic name Taphrina to include the many-spored Exoascales and the generic name Exoascus to include the eight-spored Exoascales. Upon this basis, as well, all forms reviewed here should be placed in the genus Taphrina, for, in all species studied, spores continue to bud within the ascus.

A recent paper by Mix (5) reviews the cultural work done up to the present time on various species of Taphrina and Exoascus. Such a review will therefore be omitted from this paper, but comparisons with previous cultural studies will be made. As described in another paper (3), the writer attempted to cultivate spores of *Taphrina coryli* Nishida during the spring and summer of 1921. Spores formed chains of conidia and occasionally they produced short hyphae when grown in hanging drops of sterile decoction made from hazel leaves. The hyphae so produced were very short-lived.

MATERIALS USED

Cultures were made of ascospores derived from the following sources: *Taphrina Johansonii* Sadebeck was obtained from catkins of *Populus tremuloides* collected by the writer in May, 1924, at Madison, Wisconsin; *Taphrina communis* from fruits of *Prunus americana* collected by Dr. George F. Weber, April, 1924, at Gainesville, Florida; *Taphrina mirabilis* from twigs of *Prunus domestica* collected by Dr. J. J. Davis, May, 1924, at Blue River, Wisconsin; *Taphrina coryli* from leaves of *Corylus americana* collected by

the writer at Madison, Wisconsin, June, 1924; *Taphrina deformans* from leaves of *Prunus persica* sent to the writer by J. C. Dunegan, of the United States Peach Disease Laboratory at Fort Valley, Georgia. This material was collected in April, 1924. Agar cultures of *Taphrina deformans* were sent to the writer by A. J. Mix, of the University of Kansas, and these cultures were used for purposes of comparison.

Taphrina coerulescens from leaves of *Quercus nigra* was obtained from Dr. Weber, of Gainesville, Florida, in April, 1924.

Taphrina coerulescens on leaves of *Quercus rubra*, and *Taphrina coerulescens* on leaves of *Quercus velutina* were collected by Dr. J. J. Davis at Blue River, Wisconsin, May, 1924.

METHODS OF ISOLATION

Since it is commonly held that a number of species of Taphrina live over winter in conidial form, perhaps on bud scales or twigs, isolations were attempted during the winter from washings of hazel and peach twigs known to have been infected the previous year. Such attempts have been unsuccessful up to date, probably because of the more rapid growth of a Dematium on the agar.

All isolations have been made from spores of mature asci. These asci were either eight-spored or contained a number of conidia produced by the budding of the ascospores. By one method small portions of leaves or fruits bearing asci were washed with sterile distilled water, and agar dilution plates were poured. A much more successful method of isolation was to fasten small infected portions to the cover of a petri dish so that the asci could eject their spores down upon the clear potato dextrose agar. These pieces of leaves or fruits were held in place by pressing them with a flamed scalpel into small drops of sterile, distilled water or into small drops of thick Le Page's glue. The discharge of the spores could be observed through the cover of the petri dish with the low power of the compound microscope, and in a few minutes the dishes were inverted and single spores located and marked. In this way, pure cultures were obtained, colonies being produced from single isolated spores.

The chief medium used for these isolations was clear filtered potato dextrose agar with a hydrogen-ion concentration of 4.5 (determined by the colorimetric method). Slants of this same agar and pea agar of unknown acidity were used for making transfers. Cultures were kept at room temperature, ordinarily, though it was found that twelve hours in the refrigerator, just following an inoculation, hastened germination of the spores.

CULTURAL CHARACTERISTICS

Taphrina Johansonii

Agar Plates.—On potato dextrose agar kept at room temperature, circular, pale pink colonies appeared within 48 hours. In two weeks time, colonies grew to be 10 to 12 mm. in diameter. They were circular, with undulating margins, convex, smooth, glistening, and opaque.

Agar Slants.—On potato dextrose agar, the growth was moderate, echinulate, glistening, opaque, convex, smooth, viscid, and pale pink in color (Fig. 1).

Taphrina communis

Agar Plates.—Colonies grew very readily on potato dextrose agar, approaching 12 mm. in diameter at the end of two weeks. They were circular with entire or undulating margins, slightly raised with umbilicate surface, and white in color.

Agar Slants.—On potato dextrose agar, growth was abundant, filiform, glistening, slightly translucent, raised, smooth, slimy, and white. In older cultures, streaks were contoured and opaque (Fig. 1).

Taphrina mirabilis

Agar Plates.—Colonies grown upon potato dextrose agar were pale pink in color, 9 to 12 mm. in diameter, circular with undulating margins, convex, smooth, glistening, and opaque.

Agar Slants.—Growth of *Taphrina mirabilis* on potato dextrose agar was moderate, echinulate, glistening, opaque, convex, smooth, viscid, and pale pink in color. The cultural characteristics of *Taphrina mirabilis* were very similar to those of *Taphrina Johansonii* (Fig.1).

Since *Taphrina communis* and *Taphrina mirabilis* show such different cultural characteristics it might be assumed that they are different species, but this will have to be tested by inoculation experiments. Atkinson (1) in 1894 separated the two, describing the fungus which produced twig pockets on *Prunus americana* as a new species, *Exoascus mirabilis*. He also reported that *Exoascus mirabilis* upon the twig and *Exoascus communis* upon the fruit might be present on a tree of *Prunus americana* at the same time. Since then, some workers have questioned the identity of these two organisms, saying that they are probably the same organism when present upon the same host. This, however, is no argument for combining the two species, for it is a well known fact that several different fungi may live parasitically upon the same plant.

Taphrina coryli

Agar Plates.—Colonies were ½ mm. in diameter at the end of three days at room temperature. At the end of two weeks, they were 15 mm. in diameter, circular with undulating margins, convex, smooth, shining, and white to yellowish. Older parts were opaque but margins were translucent. Colonies of *Taphrina coryli* were thus distinct from colonies of *Taphrina communis* which were opaque throughout, and contoured instead of smooth.

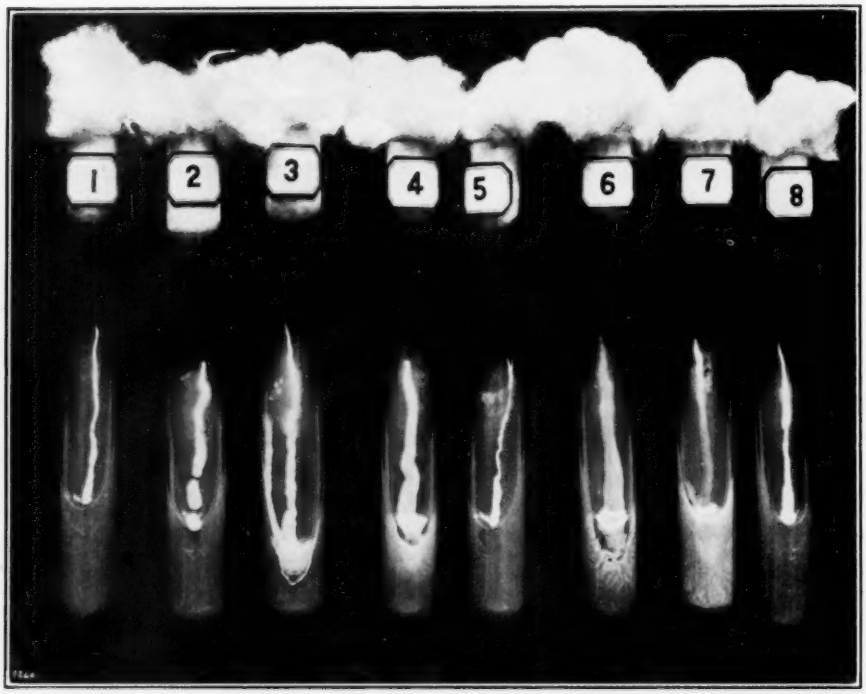

FIG. 1. Potato dextrose agar slants of various species of Taphrina incubated for five days at room temperature. 1. *Taphrina Johansonii* Sadebeck isolated from catkins of *Populus tremuloides*. 2. *Taphrina communis* Sadebeck isolated from fruits of *Prunus americana*. 3. *Taphrina mirabilis* Atkinson isolated from twigs of *Prunus domestica*. 4. *Taphrina coryli* Nishida isolated from leaves of *Corylus americana*. 5. *Taphrina deformans* Tulasne isolated from leaves of *Prunus persica*. 6. *Taphrina coerulescens* (Mont. et Desm.) Tul. isolated from leaves of *Quercus nigra*. 7. The same isolated from leaves of *Quercus rubra*. 8. The same isolated from leaves of *Quercus velutina*.

Agar Slants.—Growth was abundant on potato dextrose agar, echinulate, glistening, and opaque except for the margins which appeared slightly translucent. The elevation of these colonies was slight, the surface smooth and the consistency slimy (Fig. 1).

Taphrina deformans

Taphrina deformans was also isolated, but only by the dilution method. Deep, lens-shaped, pale pink colonies were formed which corresponded very closely to the deep colonies described by Mix (5) for *Exoascus deformans*. Since transfers to agar slants produced a very feeble growth, cultures provided by A. J. Mix were used to compare with other species (Fig 1).

Taphrina coerulescens

Agar Plates.—Colonies of *Taphrina coerulescens* isolated from *Quercus nigra* were rose pink in color, becoming a deeper rose color as the culture aged. Colonies were circular with undulating margins and surfaces, and slightly raised.

Agar Slants.—Growth was abundant on potato dextrose agar, filiform, glistening, and opaque. The elevation was slight, the surface smooth, and the consistency viscid (Fig. 1).

Similar colonies of *Taphrina coerulescens* were also isolated from *Quercus rubra* and from *Quercus velutina*. Those from *Quercus rubra* were a lighter shade of pink than those described above, and colonies isolated from *Quercus velutina* were a very pale pink, similar to *Taphrina Johansonii*. The last two and *Taphrina deformans* and *Taphrina mirabilis* were almost identical in their appearance upon agar, it being very difficult to differentiate one from the other. All species of Taphrina studied were grown upon beef malt agar and upon pea agar. Upon these media, growth was effuse and darker in color corresponding to the color of the media.

INOCULATIONS

In order to establish the pathological relationship of the various species of Taphrina isolated, two of them, *Taphrina deformans* and *Taphrina coerulescens*, were inoculated into their respective hosts, the Elberta peach and the bur oak.

One year old peach trees were sprayed April 20, 1924, with a water suspension of budding conidia of *Taphrina deformans*. These conidia were obtained from an agar culture provided by Professor A. J. Mix, of the University of Kansas. The trees were kept in a moist chamber for forty-eight hours and were then moved to a shady part of the greenhouse. Conidia continued to bud on the surface of the leaves, finally stretching out to form long hyphae. These appeared to be typical vegetative hyphae, as shown by their dichotomous branching and by the clear septa between cells. By means of the cotton blue differential stain, the hyphae were seen penetrating the stomata of the peach leaves twenty-five days after inoculation (Fig.

2 G). Shortly afterward, the fungal cells became plasmolized and the characteristic symptom of the disease, leaf curl, did not occur. This was probably due to lack of humidity and the high temperature of the greenhouse.

Inoculation experiments with the bur oak were carried on out-doors with much better results. Seedlings were sprayed with a spore suspension of *Taphrina coerulescens* on a dark, cloudy day, and three days of rain followed the inoculation. Plants were sprayed May 11, 1924, and by June 4,

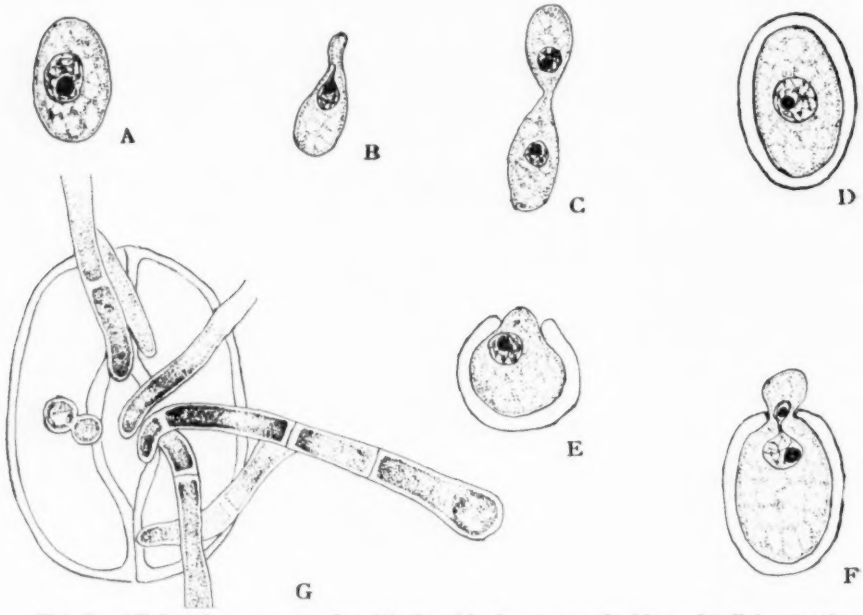

FIG. 2. All drawings were made with the aid of a camera lucida and a Zeiss apochromatic microscope—magnification 3,600, except for G, magnification 1,600. A. Ascospore of *Taphrina communis*.—B, C. Early and late stages of budding ascospores of *Taphrina Johansonii*.—D. Thick-walled resting cell of *Taphrina Johansonii*.—E, F. Germination of resting cell of *Taphrina Johansonii*.—G. Germinating spores of *Taphrina deformans* and hyphae entering stoma of peach leaf (drawn from living material).

1924, hyphae were observed entering the stomata. Grey velvety depressions, as described by Tulasne (7), were later observed on the surface of the leaves. On June 24, forty-four days after inoculation, sections of the lesions were made, and a microscopic examination showed ascogenous cells beneath the cuticle, and eight to sixteen-spored asci upon the surface of the leaf.

Since the culture used in inoculating the bur oak was one isolated from *Quercus nigra*, it would appear that the organism *Taphrina coerulescens* is not distinct for each of its hosts. However, as mentioned previously, agar cultures of *Taphrina coerulescens* isolated from three different species

of oaks were very distinct from each other. Cultural characteristics would therefore lead one to separate the three, but the effects upon the hosts seem to indicate but a single species.

MORPHOLOGICAL CHARACTERS

Budding Conidia

All forms isolated might easily have been mistaken for bacterial colonies, but upon microscopic examination the edge of a colony appeared granular and was found to be composed of budding conidia. Material was removed from the edge and from the center of plate cultures and stippled on to egg albumen on slides and dried. Later, the following fixatives were used: Merkel's, Flemming's weak, and Buoin's solutions. Merkel's proved the most satisfactory. Material was also fixed before stippling on to slides, but results with both methods proved to be the same.

Material from the margin of the colony consisted of small thin-walled conidia. These were ovoid or nearly spherical in form, depending upon the species of Taphrina. The following table shows the distinguishing features of conidia from each species studied:

Species	Form	Size at end of two weeks		Other distinguishing characters
		Minimum	Maximum	
T. Johansonii	Ovoid	1.1 × 2.28μ	3.4 × 6.8 μ	
T. communis	Ovoid	1.1 × 2.28μ	3.4 × 5.7 μ	
T. mirabilis	Ovoid	1.7 × 3.4 μ	3.4 × 4.56μ	
T. coryli	Ovoid	1.7 × 3.4 μ	3.4 × 5.7 μ	Long neck between conidia
T. deformans	Almost spherical	2 × 3.4 μ	4.5 × 5.7 μ	
T. coerulescens from three hosts	Nearly spherical to ovoid	3.4 × 4.5 μ	4.56 × 7.9 μ	Cytoplasm arranged in 1 or 2 peripheral bands

The conidia of *Taphrina coerulescens* were much the largest of the various species studied, and they were also easily distinguished by the arrangement of cytoplasm in one or two distinct peripheral bands. In all species the cytoplasm was finely granular and contained large vacuoles. Each conidium contained one nucleus. The chromatin, linin, and nucleole were clearly distinguishable.

As previously mentioned, budding was conspicuous along the margin of colonies. This process appeared to be similar to that in cultures described by Pierce (6) and by Mix for *Exoascus deformans*, by Klebahn (2) for a number of Taphrina species, and by the writer for *Taphrina coryli* Nishida. In the forms reported in the present paper, an individual conidium lengthened out, its wall furrowed in on one side and then on the opposite side

usually above or below the equator so that the two spores varied in size. The smaller spore thus produced increased in size, however, until the two appeared about equal. Preceding cell division, there was nuclear division, so that each of the conidia contained one nucleus. Nuclear division took place directly. The nucleus stretched out in the form of a dumb-bell, and later, the two parts separated.

The formation of conidia in this manner continued to the extent that in a few cases five or six cells might remain connected. Ordinarily, however, only two or three cells formed a chain, the others having been separated shortly after their growth was completed. As mentioned in another paper, a conidium may be observed budding so that within one half hour a group of three will be formed. A few short hyphae were observed in liquid media but these were rare. They appeared to be extensions from budding conidia.

ATYPICAL SPORES

It was noted that the centers of plate colonies of all forms became more dense and lost their luster as the culture grew older. From these centers, two types of cells were removed, the small, thin-walled conidia and the large, thick-walled, shining atypical spores. The latter appeared to correspond quite closely to those described by Mix for *Exoascus deformans* and designated by him as resting cells. Such cells were much larger than the conidia in all species, as is shown by the following table:

Species	Form	Size at end of two weeks		Other distinguishing characters
		Minimum	Maximum	
T. Johansonii	Ovoid	3.42 × 5.7 μ	5.7 × 6.8 μ	All appeared similar
T. communis	Ovoid	2.2 × 4.56μ	4 × 7.9 μ	
T. mirabilis	Ovoid	3.42 × 3.42μ	7.98× 7.98μ	
T. coryli	Ovoid to almost spherical	3.99 × 4.56μ	4.56× 5.7 μ	
T. deformans	Almost spherical	4.56 × 5.7 μ	10.2 ×10.2 μ	
T. coerulescens	Ovoid	4.56 × 6.8 μ	6.8 ×10.2 μ	

When the triple stain was used, these large, thick-walled spores were much slower to take the stain than were the conidia. However, the cytoplasm stained quite readily with orange G and the chromatin slightly with gentian violet. Every spore contained very dense cytoplasm and one large nucleus.

Some of the atypical spores were observed in the process of germination. This process consisted of the rupturing of the thick wall of the spore, either at one end or one side, and the outward projection of the contents. The

part projected proceeded to constrict and to produce conidia after the manner described for budding conidia.

The atypical thick-walled spores or resting cells may be the result of changed physiological conditions. Due to crowding and changed nutrients, it may be that the ordinary conidia accumulate a reserve food supply and form a thick wall. Mix and Pierce have considered these cells similar to ascogenous cells in their development. Pierce compared the development of an ascus from an ascogenous cell to the germination of a heavy-walled spore, the outgrowth of an endospore through the rupturing of an epispore. However, in the writer's preparations (as described in a previous paper), asci were formed by the direct growth of the ascogenous cells. The walls of these cells by their growth and stretching became walls of the asci. There was no breaking of the wall until the time for ejection of spores. It would therefore seem that the atypical spores are not related to asci nor to ascogenous cells, but that they are rather an adjustment of conidia to changed environmental conditions.

It is possible that the thick-walled resting cells represent the condition in which these species of Taphrina pass the winter. Twigs were washed and scraped at various times during two winters, but neither conidia nor thick-walled cells such as have been described were found. In a study of fixed material, however, cells which appeared in every respect to be thick-walled resting cells were observed in groups among mature asci of *Taphrina deformans* upon leaves of *Prunus persica*. This material was collected and fixed by the writer May 17, 1922, in Salina, Kansas.

SUMMARY

1. Spores of *Taphrina Johansonii, Taphrina communis, Taphrina mirabilis, Taphrina coryli, Taphrina deformans, and Taphrina coerulescens* from three different species of Quercus were isolated and grown upon agar.

2. Cleared potato dextrose agar with a hydrogen-ion concentration of 4.5 was used for all isolations, and material containing asci was fastened to the covers of petri dishes so that the spores might be discharged upon the agar. Pure cultures were obtained from single spore isolations. These species of Taphrina also grew well upon pea agar and upon malt agar.

3. Colonies of all species appeared like bacterial colonies in culture, but upon microscopic examination were found to be composed of budding conidia. Conidia were uninucleate, and amitotic nuclear division took place preceding cell division. In a few cases, conidia stretched out to form short hyphae.

4. Inoculation experiments were carried on with conidia of *Taphrina deformans* and *Taphrina coerulescens*. In both cases, spores germinated to

form hyphae which entered the stomata of the hosts. *Taphrina coerulescens* produced characteristic lesions, and eight to sixteen-spored asci after forty-four days, out of doors.

5. In the centers of all old colonies,thick-walled resting cells, which were uninucleate, were found. These germinated by a rupturing of the wall. Contents of the cell projected out and continued the process of budding. Amitotic nuclear division took place at the time of germination.

The writer is much indebted to Professor E. M. Gilbert and to Professor G. W. Keitt, of the University of Wisconsin, for valuable suggestions in this work.

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SUSCEPTIBILITY OF NICOTIANA SPECIES, VARIETIES AND HYBRIDS TO TOBACCO WILDFIRE

P. J. Anderson

The origin of tobacco wildfire is an unsolved riddle. It suddenly appeared in North Carolina in 1916 and in a few years has spread to all tobacco sections of America. But where was it before 1916? Nobody knows. It is known that many pathogenes which suddenly appear and ravage a cultivated crop lived originally on some related wild host. But when the writer began working on this disease four years ago, wildfire had never been found on other host plants. He therefore started a series of infection experiments to see whether the disease would affect other plants besides cultivated tobacco. In a quest of this kind one first suspects the different varieties of the same species which has the disease, then the different species of the same genus, then species of the same family. Although a few species outside the genus Nicotiana have been tested, the bulk of the work up to the present has been within this genus. This paper deals only with results of inoculations within the genus Nicotiana.

There was also a more directly economic reason for undertaking the investigation. It was hoped that some resistant varieties of tobacco or species of Nicotiana might be found which would serve as a basis for development of a desirable resistant kind of tobacco.

METHODS

The time-consuming phase of this work was the collection of seed of a large number of species and varieties. For many of these I am especially indebted to Dr. R. E. Clausen of the University of California and Dr. J. J. Johnson of the University of Wisconsin. Most of the others were secured from the seed houses in Germany, France, and England. Nicotiana is a genus of about 40 species but, up to the present, seed of only 20 species has been secured. Varieties and strains of the species *N. tabacum* are so numerous that one hardly hopes to test all of them, but the group which was tried is probably fairly representative of the species. Seed of all species and varieties was sown in plots in tobacco beds in the usual way in which tobacco is started in the Connecticut Valley. Inoculations were begun as soon as the leaves were as large as the fingernail. Inoculation was repeated every day or two for four weeks or more. The method of inoculation was one which has been successfully used by the writer for several years in securing a high percentage of infection in tobacco beds on a large scale:

A young wildfire spot on a tobacco leaf is cut out, sterilized, washed and transferred to a flask of nutrient bouillon. As soon as the bouillon has clouded—24 to 48 hours—it is poured into a sprinkling can of water and the water sprinkled over the plants in the bed. The inoculations are made in the evening in order that the infested drops of water may remain on the leaves over night before drying down. The same results may be accomplished by inoculating the flasks from a pure culture each day, but it is the writer's impression that this has not resulted in as thorough infection as when the strain was isolated from a fresh lesion every day. Of course, one cannot be sure that his flask cultures are always pure cultures of *B. tabacum*, but since it is hardly probable that any other disease would be confused with wildfire, the chance of error from this source is negligible. Where it was necessary to inoculate several square rods of bed every day, this method could be used with the minimum amount of labor. In numerous trials with *N. tabacum*, this method has given close to 100 per cent. of infected plants, and frequently the plants were so covered with lesions that large numbers of them died. The plants were never previously wounded by needle pricks or other artificial means and no bell jars were kept over them. They were kept as nearly as possible under the conditions which a tobacco grower would maintain for his beds. These latter points should be kept in mind in comparing the results which the writer obtained with those recently reported by Johnson, Slagg and Murwin.[1] Their tests were with plants grown in pots in the greenhouse, and their list of susceptible species is based on results secured by first puncturing the leaves with needles and then keeping the plants in a moist chamber for one or two days after inoculation. In this way they were able to infect all species and varieties tried, but state that "fairly marked differences occurred when the organism was applied by the atomizer only," *i.e.*, without puncturing the leaves.

There were at least several hundred, and frequently more than a thousand seedlings in the plots of each species and variety tested by the present writer. The tests have been repeated for most of them at least once during the work. No attempt was made to count the number of infected plants or the number of lesions, because the work involved would be out of proportion to the value of the results. Susceptibility was rated by periodical observation and estimation of the severity of infection as compared with that of a Havana strain of *N. tabacum* which was inoculated in the same way and under the same conditions. The Havana was affected to approximately the same extent in all the tests and for purposes of comparison was called 100 and all comparisons of others made on that basis.

[1] Johnson, James, C. M. Slagg and H. F. Murwin. Host plants of Bacterium tabacum. Phytopathology **14**: 175–180. 1924.

VARIETIES OF NICOTIANA TABACUM

Almost all of the kinds of tobacco which are cultivated in various parts of the world and come into commerce are forms of the species *N. tabacum*. Comes, the most widely recognized authority on the taxonomy of the genus, divides *N. tabacum* into six primary varieties which have morphological characters sufficiently distinct to warrant a botanist in calling them true varieties.[1] All these varieties however have been crossed and the resulting hybrids crossed again and again until now there are literally hundreds of these creations, many of which have received popular names and are extensively grown locally, *e.g.*, White Burley, Orinoco, Blue Prior, Maryland Broad-Leaf, Zimmer Spanish, Little Dutch, etc. Others are merely the results of long continued selection without crossing, *e.g.*, Havana Seed-leaf, Cuban, Pennsylvania Broad-leaf are selections from *N. tabacum* var. *havanensis*. Thus, by these two processes, we have numerous kinds of tobacco and each large tobacco growing section grows one or more kinds which are different from what are grown in other sections. We may designate these as horticultural varieties to distinguish them from the botanical varieties of Comes. The fact that wildfire has been reported from most of the tobacco sections of the United States and that no claims of resistance have been made for any section, leads one to believe that there are probably no resistant varieties among those cultivated in this country. Among the four varieties cultivated in the Connecticut Valley, the writer has never noticed any difference in amount of infection. Varieties from other countries, however, have not been tested, as far as any published records show. The writer was able to obtain from various sources 41 varieties, some of them botanical varieties, but mostly horticultural varieties. All of these were grown simultaneously and inoculated in the same way. As indicated in Table 1, all of them were found to be susceptible to wildfire and most of them did not differ materially from our Connecticut Havana strain in severity of infection. Those which showed the least amount of infection were Maryland, Hester, Bafra, and Sumatra, in the order named. The differences between the others were hardly sufficient to be significant. Since only a single test was made, the four last named varieties are being tested again before any definite conclusions are formed as to their resistance. Johnson, Slagg and Murwin tested five of the above 41 varieties, *viz.*, *angustifolia*, *atropurpureum*, *calyciflora*, *laterrima*, and *chinensis*, and in addition, *macrophylla*, *trigonophylla*, and *campanulata*. They reported all as uniformly susceptible. (The inclusion of the last named variety under *N. tabacum* is probably an oversight. Dr. Johnson very kindly sent some seed of it to the writer, who found it to be a typical rustica-form—*N. rustica* var. *texana* of Comes.)

[1] Comes, O. Monographie du genre Nicotiana. Naples. 1899.

TABLE 1.—*Relative susceptibility of species and varieties of Nicotiana in comparison with Havana seed leaf = 100.*

Species and Variety	No. of trials	Average condition compared with Havana 100
N. Tabacum L.		
var. lancefolia (W.) (*N. angustifolia* Ehrh..)	1	80
" fruticosa Hook	1	65
" brasiliensis	1	100
" sanguinea (macrophylla purpurea)	1	80
" chinensis	1	100
" calyciflora	1	100
" atropurpurea (purpurea?)	1	100
" laterrima	1	140
Havana seed leaf	10	100
Cuban seed leaf	10	100
Ct. broadleaf	10	100
Pa. broadleaf	1	100
Sumatra	1	30
Yara	1	100
des Indes Rano de Sumatra	1	100
Zimmer Spanish	1	100
Comstock Spanish	1	100
Small Havana	1	130
Canelle	1	110
Mexican	1	100
White stem Orinoko	1	100
Little Dutch	1	125
Allateban	1	80
White Burley stand-up	1	125
White Burley broad-leaf	1	100
Blue Prior	1	125
Big Ohio	1	100
Turc aromatic	1	60
de Hongrie Muscatel	1	100
de Hongrie Szamoshati	1	100
Delhi	1	100
grandiflora purpurea	1	100
des Indes Pajacombo	1	100
Persian rose	1	100
Hester	1	10
Espado	1	100
Samsoan	1	75
Obowig long leaf	1	90
Bafra	1	20
Maryland	1	3
Hickory Prior	1	100

TABLE 1.—(*Continued.*)

Species and Variety	No. of trials	Average condition compared with Havana 100
N. rustica L.		
var. humilis	2	0
" asiatica (English tobacco)	2	0
" texana (*N. campanulata*)	2	0
" brasilia (Erbasanta)	1	0
" Iowa	2	0
Brasile lecesse	1	0
Makhorka	1	0
N. alata Lk.		
var. persica	6	0
" grandiflora Com. (*N. affinis*)	3	2
affinis hybrida	1	1
N. acuminata Grah.	2	55
N. attenuata Torr.	1	0
N. Biglovii Wats.	1	40
N. Colossea Andr. (*Lehmannia tomentosa* Spr.)	1	100
N. glutinosa L.	2	75
N. glauca Grah.	1	120
N. Langsdorffii Weinm.	1	95
N. longiflora Cav.	2	35
N. nudicaulis G. Watson	2	0
N. paniculata L.	2	125
N. plumbaginifolia Viv.	2	135
N. quadrivalvis Pursh var. *multivalvis* Gr.	1	85
N. repanda W.	2	0
N. Sanderae (*alta grandiflora* x *Forgetiana*)	2	30
N. suaveolens Lehm.	1	25
N. sylvestris Speg.	1	125
N. wigandioides Englm.	1	100

VARIETIES OF NICOTIANA RUSTICA

The tobacco which was used by the Indians of continental North America before the time of Columbus and which was first introduced into Europe was *N. rustica* L, indigenous to Texas and Mexico. The writer was able to secure seed of seven varieties of this species as given in Table 1. (The last two varieties may not be distinct from some of the others, however.) All the varieties are very rapid, sturdy growers, easily distinguished from any of the varieties of *N. tabacum*, not only by the short yellow flowers and globose pods, but also by the thick blue-green leaves. Eleven sowings were made with the seven varieties and all were thoroughly inoculated just as

the other species of Nicotiana, but, in striking contrast to the varieties of *N. tabacum* growing all about, no wildfire appeared on any of them. On the thousands of plants inoculated during two years perhaps a dozen wildfire spots have been found and these developed hardly at all. There was no difference between the seven varieties; all were uniformly so resistant that they could virtually be called immune. Johnson, Slagg and Murwin report this as a susceptible species but do not state what variety was tested.

VARIETIES OF NICOTIANA ALATA

During the summer of 1923, the writer inoculated a greenhouse bed of some thousands of plants of Havana seed-leaf with the purpose of finding whether any individual plant could be found which showed resistance. The bed was inoculated every evening for two months and as fast as any plants showed considerable infection, they were culled out. The result was 100 per cent. of infection on the Havana plants, but nine plants were found growing among the others which were different from the Havana plants and which (with one exception) were immune from wildfire. When they came into bloom they were identified as belonging to the species *N. alata* but not corresponding exactly to any described variety of that species. The fact that most of the pollen was sterile, that only five of the plants ever set seed—and then only a few pods—and that their characters were not entirely uniform, indicated a hybrid origin. They resembled most closely *N. alata* var. *persica*, the famous Persian tobacco, native of South America but grown most extensively in parts of Persia, and used mostly in blending, on account of its superior aroma. The seed of the few pods which matured was sowed and the resultant plants thoroughly inoculated, but they were again found to be immune. This form is called simply *N. alata* in further investigations, since it could not be definitely placed in any described variety.

Another variety of *N. alata*, extensively used as a garden ornamental on account of its very large, showy, white flowers is variety *grandiflora*, commonly sold under the horticultural name of *N. affinis*. Seed of this variety from three different sources was sown and the plants in every case found to be highly resistant, but not quite immune. A purple variety received from Vilmorin under the name of *N. affinis hybrida* also developed barely 1 per cent. of infection. *N. Sanderae*, a hybrid between *N. affinis* and *N. forgetiana*, was tested from two lots of seed from different sources. The first planting developed 60 per cent. infection, the second hardly 1 per cent. Since the parent species, *N. forgetiana*, has not been tested for susceptibility, no explanation of the erratic behavior of the hybrid is offered.

Altogether, the forms of *N. alata* show a very marked resistance to wildfire, amounting almost to immunity.

OTHER SPECIES OF NICOTIANA

Sixteen other species, as named in Table 1, were tested in the same manner as the above. As indicated there, the amount of susceptibility varied from those which were quite immune to others which were much more severely affected than *N. tabacum*. *Nicotiana repanda* and *N. nudicaulis* were particularly prominent for the high degree of resistance exhibited. No spots appeared on either of them. *Nicotiana repanda* is reported by Johnson, Slagg and Murwin as a susceptible species along with eight more of the sixteen listed here.

HYBRIDS BETWEEN RESISTANT AND SUSCEPTIBLE SPECIES

It has long been known that, although in nature there is very little hybridizing in the genus Nicotiana, all the varieties within a species may be crossed at will and that hybrids may be produced even between many of the species. It was hoped that some resistant variety might be found in the genus *N. tabacum* which would be resistant enough to serve as a parent for breeding a resistant desirable strain of Havana, but no such variety has yet been fully demonstrated. In order to watch the behavior of the resistance factor in crossing, it was decided to cross some of the most resistant species with Havana and determine the condition of the hybrids as to wildfire susceptibility by inoculations. *Nicotiana rustica, N. alata, N. nudicaulis, N. repanda* and *N. Sanderae* were selected as representatives of resistant species. (In a later test Sanderae did not prove so resistant.) All efforts to cross *N. rustica* (varieties Iowa, humilis and English) with *N. tabacum* failed, although it is reported that this cross has been made by others.[1] The same lack of success characterized all efforts to cross *N. repanda* and *N. tabacum*.

Nicotiana alata x *N. tabacum*. It was not found possible to make this cross when *N. alata* was used as the female parent, but it was comparatively easy to get seed when *N. tabacum* was the female parent. The vitality of the seed, however, was very low. Not over 1 per cent. of the seed grew, but, after starting, the plants grew vigorously. The hybrids did not vary markedly in characters despite the suspected hybrid condition of the male parent. They were almost perfect intermediates between the parents in stature, size and shape of leaves, habit of growth, color, shape and size of flowers and most, but not all, of the other vegetative characters. The hybrids proved to be entirely resistant like *N. alata i.e.*, resistance seems to be the dominant character. The pollen of the hybrid is sterile and, although fifty or more plants were grown to maturity, not a single pod of

[1]East, H. M., and H. K. Hayes. Heterozygosis in evolution and in plant breeding. U. S. Dept. Agri. Bur. Pl. Ind. Bul. 243. 1912.

seed was matured. The pods drop immediately after the corolla withers. Even when the hybrid flowers were pollinated with pollen from *N. tabacum* no seed was produced. Crosses were also made between *N. alata grandiflora* and *N. tabacum*, but the seed did not germinate.

Nicotiana nudicaulis x *N. tabacum*. The experience with this cross was identical with that of the *N. alata* x *N. tabacum* hybrid in that they could be crossed only when *N. tabacum* was the female parent, in the low germination, in the blending of the characters of the parents, sterility of pollen and lack of seed set. These hybrids were found to be entirely resistant like the male parent.

Nicotiana Sanderae x *N. tabacum* was a repetition of the above results except that the resultant hybrid was slightly susceptible (as the male parent also proved to be in later tests).

There are other possibilities which have not yet been tried but up to the present, the outlook for securing a resistant tobacco by interspecific crossing does not look encouraging on account of the failure of the hybrids to set seed.

SUMMARY

1. None of the 41 horticultural and botanical varieties of *Nicotiana tabacum* has been shown to possess any significant degree of resistance to wildfire.

2. All varieties of *Nicotiana rustica* and *N. alata* which were tried, also *N. repanda*, *N. nudicaulis* and *N. attenuata* are highly resistant.

3. *Nicotiana acuminata*, *Biglovii*, *colossea*, *glutinosa*, *glauca*, *Langsdorffii*, *longiflora*, *paniculata*, *plumbaginifolia*, *quadravalvis*, *Sanderae*, *suaveolens*, *sylvestris* and *wigandioides* are susceptible but vary in degree of susceptibility from some which are fairly resistant to those which are much more susceptible than *N. Tabacum*.

4. When the resistant species *N. nudicaulis* and *N. alata* are crossed with the susceptible *N. Tabacum* the resultant hybrids are resistant.

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FIELD OBSERVATIONS ON FALSE BLOSSOM OF THE CULTIVATED CRANBERRY

NEIL E. STEVENS

False blossom is perhaps less understood than any other disease of the cultivated cranberry. It is no exaggeration to state that although published reference to this disease was made in 1908 and the disease has certainly been present, at least in Wisconsin, for many years, there is no agreement as to its cause nor has any practical means of control been discovered.

It may fairly be questioned whether from a strictly scientific point of view it is worth while to publish a discussion of a disease about which so little is known. Practically, however, it is necessary for cranberry growers to deal with this problem and a summary of field observations to date may be of value.

KNOWN DISTRIBUTION

False blossom was first discovered in Wisconsin and is more generally distributed and important in that state than any other. The disease is well established, however, in the cranberry regions of Massachusetts and New Jersey. In Oregon it was found in 1922 on all bogs on which vines from Wisconsin had been planted. False blossom is known to be present on over forty different bogs in Massachusetts and a list of known infections is kept by the staff of the cranberry station at East Wareham. Although no systematic search has been made in New Jersey, the disease is known to occur in various widely separated localities within that state.

VARIETAL RESISTANCE OR SUSCEPTIBILITY

At present there is no widely grown variety of cranberry which is free from false blossom. In 1920, Fracker (1) called attention to the fact that in the course of several years nursery inspection in Wisconsin no false blossom had been found on vines of the Searls variety and that it was rare on McFarlins. The following spring (1920) the writer planted a barrel of Searls vines on a newly scalped area in one of the worst infected bogs in Massachusetts. Within three years many of these vines were badly infected and in 1924 false blossom was present on a large majority of the Searls vines. In 1922 false blossom was found on vines of the Searls variety in Oregon and it has been found on McFarlins in both Massachusetts and New Jersey.

Locally, at least, there is an apparent difference in the susceptibility of different varieties. The Holliston (Mamouth) variety seems to be very generally infected in Plymouth County, Massachusetts. In the same region Howes seem to be more generally infected than Early Blacks. The only New Jersey bog on which Hollistons are known to have been planted is badly infected with false blossom. Here, as in Plymouth County, Massachusetts, Howes are more generally infected than Early Blacks. Native Jerseys are, however, very susceptible. These relations may not hold in other regions.

The statements made in this paper as to the occurrence of false blossom on different eastern varieties are not based merely on finding the disease in a section planted to a given variety, but in each case typical berries have been found on vines affected with false blossom. In almost any bog in which the infection is not too severe it is possible with sufficient care to separate from the mass of intertwined vines single plants, one portion of which is apparently normal, or at least bears normal berries, and another portion of which is obviously affected with false blossom. This observation has been repeated many times and may be readily verified by any one who will take time to separate out the vines. The vines may be more easily separated of course on unsanded bogs. In no case has the writer relied solely on his own judgment in determining the variety but has referred the specimen for identification to some one whose familiarity with the variety would place the determination beyond question, Dr. Franklin in Massachusetts, Miss White or Mr. Scammell in New Jersey, and Mr. Lewis in Wisconsin.

THE SPREAD OF THE DISEASE TO NEW VINES

In the absence of definite proof of the nature of the disease, opinion as to its spread must be based on field observations. In 1914 Shear and Franklin made a survey of false blossom conditions in the vicinity of North Carver, Massachusetts, where they found the disease present on five bogs. Their observations, which were reported separately (1, 2), are in full agreement that in all cases the vines worst infected with false blossom were Wisconsin vines which had been planted on small areas, and that there was very little infection on Massachusetts varieties. In discussing the apparent spread to eastern varieties, Franklin (p. 100) uses the terms "was found to some extent" and "to a slight extent," while Shear says (p. 3), "In both Massachusetts and New Jersey a few scattered vines showing the disease have been found in plantings of eastern varieties in the same bogs." The New Jersey bog here referred to is one on which a small plot of Wisconsin vines had been planted about 1909, and on which false blossom was first noticed in 1915.

The reports of these careful and competent observers can leave no doubt that in 1914 the infection of Eastern varieties on these six bogs was not severe. The Wisconsin vines were, however, removed from all five of the Massachusetts bogs within the next year.

In 1924, ten years after the observations reported by Shear and Franklin, the following condition exists: False blossom is present on undoubted eastern varieties on all five bogs at North Carver, Massachusetts. On the most severely infected of the bogs false blossom is found to some extent over practically its entire area (eighteen acres), while several sections have become so badly infected as to become worthless and have been torn out and replanted. On the other bogs false blossom is present to an injurious extent over areas varying from one-half acre to several acres, a condition which contrasts strikingly with the "few scattered vines" of the 1914 report. The New Jersey bog referred to in Shear's report was visited in 1924 by Miss Elizabeth White and the writer. False blossom is now present on Centennials over practically the entire bog and is readily found at a distance of one hundred yards or more from the original planting of Wisconsin vines.

Such observations suggest the possibility that false blossom is an infectious disease and has spread to the eastern vines from the diseased vines which were planted near them. If, as has been suggested, false blossom is "a physiological disturbance due to unfavorable cultural conditions," the conditions on all six of these bogs must have been so unfavorable as to induce the spread of the disease in varying amounts. This is, of course, possible.

It does not seem at all probable, however, that unfavorable cultural conditions can account for the following instance. In 1915, after the general survey of the false blossom situation in Massachusetts already mentioned, Dr. Franklin planted three sods of Wisconsin vines affected with false blossom on one of the sections (Number 13) of Howes in the State Experiment bog at East Wareham, a careful survey of the state bog having failed to show any false blossom. At that time it was generally believed that false blossom was not infectious and that diseased plants would recover under favorable conditions. The test was made to determine whether, under the cultural conditions found at the state bog, the affected plants would recover. The transplanted false blossom vines did not recover, but after a few years died out and the space was filled with Howes vines. At the present time (1924), however, there is some false blossom on the Howes near where the diseased sods were set and a locally severe infection of Howes on Section 7 across the main ditch. A natural inference would be that the false blossom had spread from the introduced infected vines to the Howes.

Related to the question of spread to new vines is the question of the distribution of the disease by the setting of diseased vines. As already noted, false blossom was found in Oregon on all bogs which had been planted with Wisconsin vines, many of which were presumably infected with false blossom. Thus far, indeed, it has been found in Oregon only on Wisconsin varieties. Franklin and Shear both call attention to the fact that false blossom in Massachusetts and New Jersey was first found on bogs where infected Wisconsin vines had been planted.

In pointing out these instances in which false blossom has apparently been introduced on eastern bogs by the planting of diseased vines from Wisconsin, it is not intended to convey the impression that such infections on eastern bogs can always be traced to Wisconsin vines. There are numerous cases in which false blossom occurs on eastern bogs where no Wisconsin vines have been set. On the other hand, the available evidence indicates that on the seven eastern bogs just referred to the first observed infection was on Wisconsin vines, and that a common means by which false blossom is introduced into new localities is by the shipment of vines already infected.

While it is certainly true that false blossom now occurs on various bogs in which no infected vines are known to have been set, it is on the contrary often possible to trace the source of at least part of the vines to some bog known to be infected. These observations suggest that it is extremely unwise to plant vines from a bog infected with false blossom. Fracker (1) sums up the situation in Wisconsin as follows:

> Even though the cause may be a physiological one, plants from infected beds continue to develop false blossoms after being transferred to new locations. The loss usually then becomes greater from year to year and total crop failure sometimes results, followed by the abandonment of the bogs. Under these circumstances the nursery inspection office must adopt the same policy in providing for cases of false blossom as if the disease were proved to be of an infectious nature.

The present writer's observations also indicate that this is the only safe course. No case is known to the writer in which a bog once known to contain false blossom plants has become free from the disease.

THE "RECOVERY" OF VINES AFFECTED WITH FALSE BLOSSOM

This raises the question of the recovery of vines affected with false blossom. Thus far all infected vines marked for observation have either continued diseased or have died. As it is not possible to keep a very large number marked, this does not disprove the possibility of their recovery. On the other hand, it is readily observable that under conditions favorable for the growth of healthy vines part of the diseased vines die out and healthy ones crowd in and take their places. This condition, the writer believes, accounts for many of the reports of "recovery" of infected vines.

RELATION OF THE DISEASE TO CULTURE CONDITIONS

In earlier publications on false blossom the disease has generally been attributed to unfavorable cultural conditions, particularly to lack of drainage or to extreme drought. Recently Scammell (1) in discussing false blossom in New Jersey said:

> False blossom is not a serious trouble with us but I have found it occurring on numbers of bogs in New Jersey, attacking such varieties as Howes, Early Black, Centennial and Jersey. It appears on our mud bottoms and our savannas, where drainage is good and where drainage is poor.

On the other hand, Franklin (5) makes the following observations:

> We have come to regard a severe attack of this disease as a mark of poor cultural conditions. Anything tending to weaken the vines seems to give it a chance. . . . We have been finding it increasingly on the bogs the last few years and we know it has increased greatly in some cases. . . . Girdler injury seems to make the vines especially susceptible to the disease.

The very week in which this part of Dr. Franklin's report was published in the Wareham Courier, Mr. Beckwith of the New Jersey Experiment Station stated to the writer that according to his own observations false blossom was most common on bogs weakened by attacks of the cranberry girdler (*Crambus hortuellus* Hübn).

No contradiction is involved in these statements, which agree in general with the writer's own observations. That is, *severe* attacks of this disease seem to be associated, at least in Massachusetts and New Jersey, as indicated by Franklin and Beckwith, with poor cultural conditions or unusual abundance of insect pests. On the other hand, the disease certainly seems to be able to maintain itself, as pointed out by Scammell, under a variety of conditions and is certainly known to occur at present on several bogs in Massachusetts on which cultural conditions, as indicated by yield and the keeping quality of the crop, are far above the average.

Several years ago it was stated on the authority of a western cranberry grower that plants from Wisconsin showing the disease had entirely (Shear, p. 5) recovered from the disease when grown on the Pacific Coast. When, however, the writer visited this region in 1922 the disease was found to some extent on every bog on which Wisconsin vines had been planted. It seems, however, to be of slight importance in this region.

It appears then that while excellent cultural conditions and the control of insect pests appear to check the rate of spread of false blossom and may even reduce the amount of disease by preventing its spread and favoring the continued growth of healthy vines to take the place of those killed by the disease, there is no indication at present that the disease may be eliminated by improving cultural conditions.

SUGGESTIONS FOR CONTROL

Whether false blossom is finally proved to be an infectious disease or not, it seems wiser to treat it as such in the field.

In case of a scattered infection it is highly desirable to improve cultural conditions in the hope that the disease may be reduced by the death of the diseased vines and the continued growth of the healthy ones.

At least one grower gets good results on a bog having a scattered infection by systematically pulling out vines infected by false blossom when weeding the bog.

On one Massachusetts bog which was in a serious condition from false blossom, Scammell's suggestion has been followed and a chemical weed killer has been used in an effort to kill all the cranberry vines preparatory to replanting with healthy ones. This drastic treatment, however, is still in the experimental stage and its general adoption is hardly to be recommended at present.

The most important precaution is to avoid planting vines from bogs known to be infected with false blossom.

It will be evident from the observations just summarized that we are still very much in the dark in our efforts to combat false blossom and it is a source of much satisfaction to those of us who are interested in the practical control of cranberry diseases that the study of false blossom has been taken up by an investigator who has had marked success in dealing with insect-borne diseases of the mosaic type.

SUMMARY

Field observations indicate that false blossom has spread on certain bogs in Massachusetts and New Jersey since its discovery there ten years ago.

Eastern varieties are now known to be infected.

The disease is able to maintain itself under very good cultural conditions.

It is suggested that until the cause of the disease is definitely established it will be wise to treat it as infectious, and carefully avoid the sale or planting of diseased vines.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

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FUSARIUM ROT OF THE PEACH

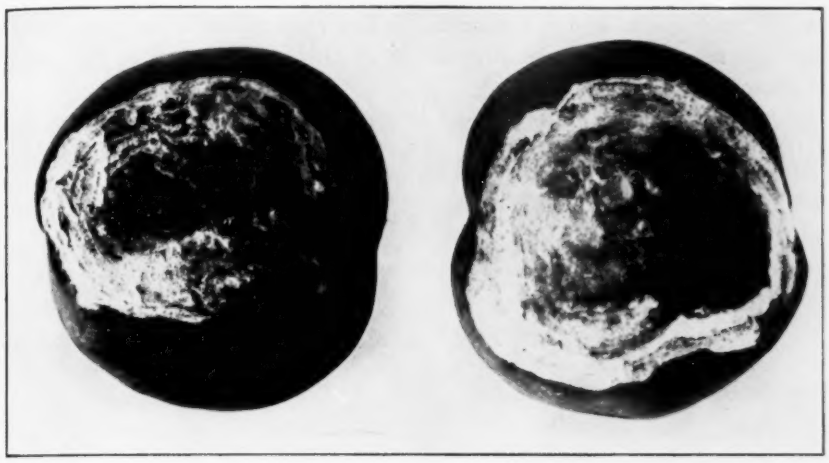
A. G. PLAKIDAS

In a recent paper, J. W. Roberts (1) described a bud rot of the peach, reported from Georgia, and caused by a species of Fusarium. The purpose of the present paper is to report: (1) The occurrence of Fusarium fruit rot of the peach in California, and (2) the development of a bud-rot, similar to that described by Roberts, on peach and apricot by artificial inoculation in the laboratory with pure cultures of three forms of Fusarium isolated from decaying peach fruit. The writer believes that this report will be of interest from the viewpoint of the geographical distribution of this type of rot.

As far as the writer knows, nothing has been published concerning Fusarium rot of the peach or of other stone fruits. In August, 1920, Prof. W. L. Howard sent from Mountain View, California, two specimens of peach fruit showing a Fusarium rot. Professor Elizabeth H. Smith, who examined these specimens, gives the following description of the rot: "This rot has never been seen previously, and it is interesting as Fusarium has never been known to take hold of the peach pulp in this way. The kernel and shell are badly damaged from the physiological gumming and splitting which has given entrance to the fungus. Two affected fruits were submitted, both showing the typical effect. A large area, including about one-half of the fruit, shows a dry rot, apparently starting at the tip and extending to the stone throughout the rotted area, the surface being covered with a thick felty layer of the mycelial growth. This is a pale pink in color, distinctly zonate and with a dense layer of spores at the base of each zone of several shades deeper salmon pink color."[1]

B. A. Rudolph, of the Mountain View Experiment Station, has observed the occurrence of Fusarium rot of peaches in the Santa Clara Valley, and has collected and examined specimens. Acknowledgment is made to Mr. Rudolph for the following information: "The fruits of both Phillips and Tuscan clings are affected, and possibly many others. The fruit is attacked just about the time it ripens. Affected fruits usually drop to the ground, but I have seen fruits in which about one-quarter of the flesh was involved still hanging on the trees. The rot I believe to be relatively a slow one. Certainly, affected fruit is not destroyed with the rapidity of, say, brown rot. Thus far the disease has been of no economic importance. However, it should be recognized."

[1] The author is indebted to Prof. E. H. Smith for the use of her records and of the plates of the photographs shown on Fig. 4.



A

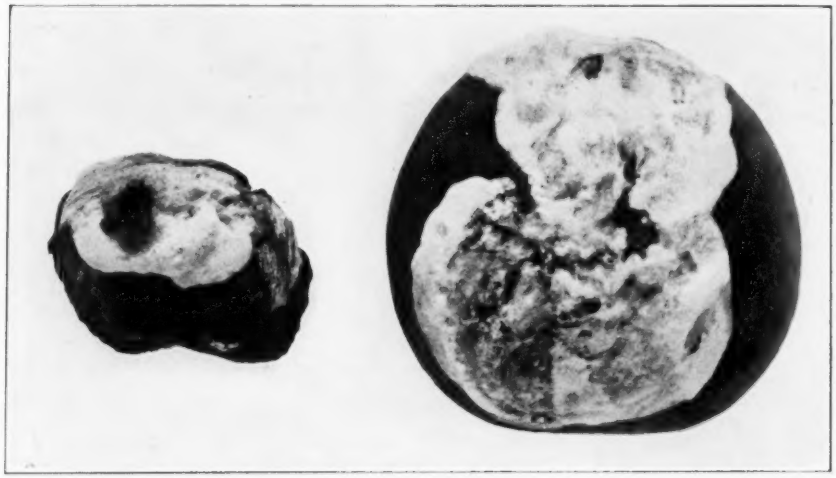
B

FIG. 4. A. Peach fruit showing Fusarium rot. From specimens sent in by Prof. Howard from Mountain View, Santa Clara Valley, in Aug., 1920. B. Specimen from the same location, collected by B. A. Rudolph, in 1922.

Early in September, 1923, the writer received a number of specimens of decaying peaches from two localities in Sutter County, Sacramento Valley, Yuba City and Nicolaus. All of these specimens were of the Phillips cling variety. Among these specimens, some were found that showed the characteristic Fusarium rot (Fig. 5 A). It is worth noting here that out of 48 specimens comprising the Yuba City lot, 4 showed Fusarium rot, while 3 more exhibiting the same kind of rot were found among the 56

specimens of the Nicolaus lot. Since the specimens were picked at random from different parts of the orchard, the fact that about 7 per cent showed Fusarium rot illustrates the prevalence of this type of rot in this region that season.

Three distinctly different forms of Fusarium were isolated from these specimens. Pure cultures of these were secured by single spore isolations.



A

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FIG. 5. A. Peach fruit showing Fusarium rot. Specimen collected from Yuba City, Sacramento Valley, Sept., 1923. B. Peach rot produced by artificial inoculation in the laboratory with pure culture of *F.*–(X_4) *pirinum* (?)

Dr. Sherbakoff identified these forms, more or less definitly,[2] as *Fusarium asclerotium* (Sherb.) Wr., *Fusarium solani* (Mart. p. part.) App. et Wr., and *Fusarium pirinum*, respectively. Therefore, it is not considered necessary in this paper to give a detailed description of these fungi.

EXPERIMENTATION

1. *Fruit inoculations:* Inoculations were made with pure cultures of these forms on fruit; peaches (Salway), oranges (Washington Navel), apples (Oregon Pippin), and lemons, in moist chambers in the laboratory. Several such inoculations were made from September to December, 1923. Both mycelium and spore inoculations were tried, puncturing and without puncturing the skin of the fruit. The fungi failed to grow on the apples and lemons, but typical Fusarium rot was produced on the peaches and oranges in every instance. (See B, Fig. 5) It must be stated, however, that the rate of decay, under laboratory conditions, was slow in every case.

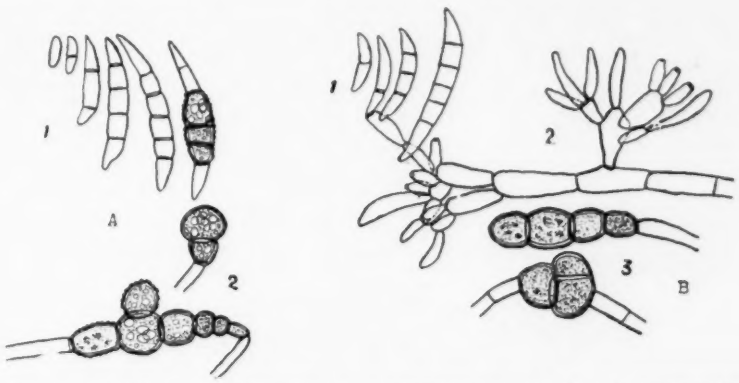

FIG. 1. Conidia, chlamydospores, and sporophores of F–X_1 (*F. asclerotium* (Sherb.) Wr. as suggested by Sherbakoff)

A. From potato plug, culture, 50 days old. 1. Conidia × 1000. 2. Chlamydospores × 1000. B. From nutrient agar, culture, 7 days old. 1. Conidia × 1000. 2. Conidiophore × 1000. 3. Chlamydospores × 1000.

[2] This is Dr. Sherbakoff's statement regarding the identification of these Fusarium forms: "... please permit me to say that, from my examination of your Fusarium X-1, I believe the form could safely be put into the species *Fusarium oxysporum* var. *asclerotium*, as the name is given in my 'Fusaria of Potatoes,' Cornell Memoir No. 6, or as renamed by Dr. Wollenweber, *F. asclerotium* (Sherb.) Wr.

"Your fungus No. X-3 is probably identical with *F. solani* (Mart. p. part.) App. et Wr.

"Your fungus X-4 corresponds very much with *F. pirinum* Fries. . . . in general it resembles very much, and probably is identical with, *F. biforme*, the latter fungus to be considered a synonym of *F. pirinum*. This matter was agreed to by Dr. Wollenweber and myself."

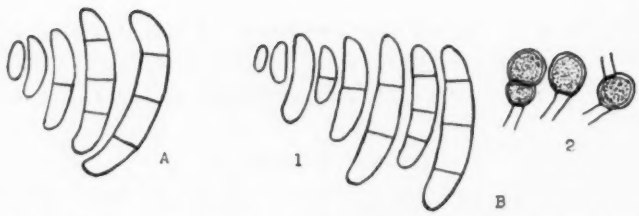

FIG. 2. Conidia and chlamydospores of F–X_2 (Probably identical with *F. solani* (Mart. p. part.) App. et Wr., according to Sherbakoff)

A. Conidia from nutrient agar, culture 7 days old. × 1000. B. From potato plug culture 55 days old. 1. Conidia × 1000. 2. Chlamydospores × 1000.

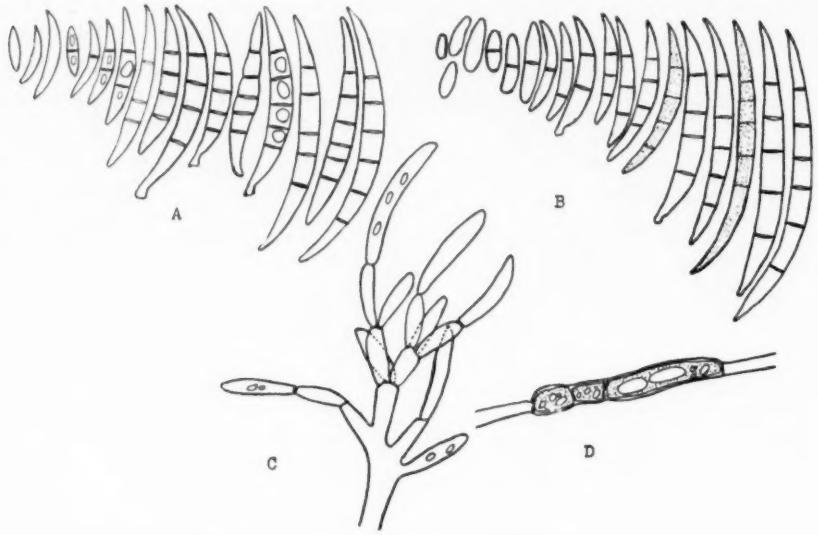

FIG. 3. Conidia, chlamydospore and conidiophore of F–X_4. (Probably *F. pirinum*, Fries)

A. Conidia of different shapes and sizes from nutrient agar, culture 13 days old. × 1000. B. Conidia from potato plug culture, 72 days old. × 1000. C. Conidiophore from potato plug culture, 13 days old. × 1000. D. Pseudo-chlamydospore; from potato plug culture, 72 days old. × 1000.

F. pirinum was the most active of the three, but even this required from 20 to 30 days entirely to rot the inoculated fruit. It was not found possible to try fruit inoculations in the field.

2. *Bud inoculations:* Peach (Elberta) and apricot (variety?) twigs were placed under bell jars, the cut ends of the twigs being immersed in water in tumblers, in the laboratory. One set of twigs was sprayed with a spore suspension in sterile water from *F. asclerotium*, another from *F. solani*, a

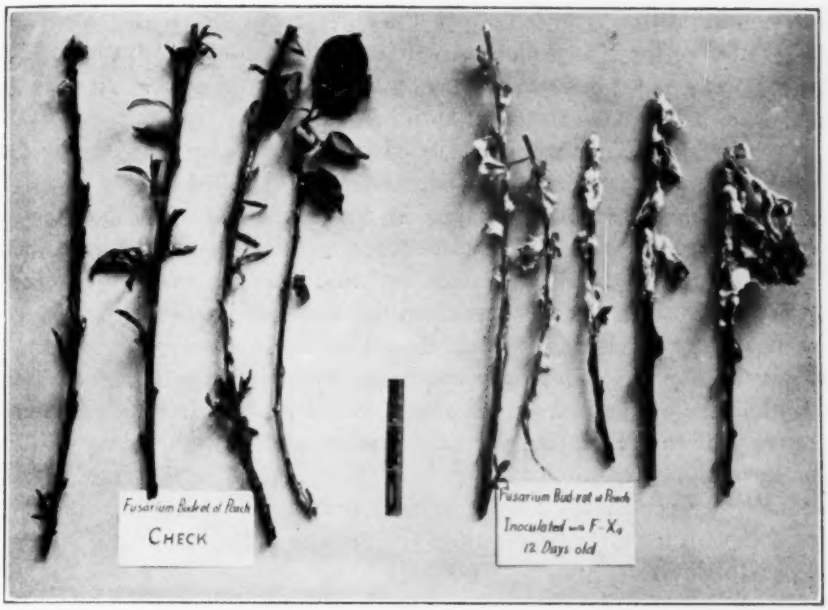

FIG. 6. Bud-rot on peach and apricot twigs, produced by artificial inoculation with spore suspension from a pure culture of *F. pirinum* (?) under a bell jar in the laboratory. The fourth twig in the check, and the fourth and fifth in the inoculated row are apricot; the rest are peach.

third from *F. pirinum*, while a fourth set was sprayed with sterile water to be used as check. The spraying was done by means of an atomizer. This experiment was started on March 14, 1924. Most of the buds, both leaf and flower, at this time were open. The results of this experiment are summarized in the table below:

TABLE 1.—*Relative effect of three species of Fusarium on inoculated peach and apricot twigs, in 10 days*

Organism	Percent of buds killed		Condition of twigs
	Apricot	Peach	
F. asclerotium	50	50	Shriveled
F. solani	100	77	Badly shriveled; dying out
F. pirinum	100	100	Dead
Check	0	0	Fresh

The *F. pirinum* set showed the most conspicuous effects. There was 100 per cent. killing of buds on both the apricot and the peach twigs. Profuse white, cottony, mycelial growth covered the blighted twigs. (See Fig. 6.) The killed buds were dark brown to black in color. At first they were somewhat water-soaked, but soon became dry.

The specific Fusaria were re-isolated in pure cultures, in every case, by plating aseptically some of the inside tissue of the killed buds.

Similar inoculations were made in the garden of the laboratory on twigs of growing peach and apricot trees. This experiment was started at the same time as that in the laboratory, and it was repeated. The inoculations failed to take. This result should not be taken as conclusive, however, especially in view of the fact that it was an unusually dry season for Berkeley at the time that the experiment was carried out. Prof. E. H. Smith told the writer that she has often isolated Fusaria from blighted twigs that are sent to the Station for examination, and that she has considered them as secondary saprophytic organisms. It is possible that, under favorable moisture conditions, like those that prevail in the California valleys during the winter and early spring, some of the killing may be due, partly at least, to Fusaria.

SUMMARY

1. The occurrence of Fusarium rot of the peach fruit in California is reported.

2. Three forms of Fusarium were isolated from specimens of decaying peaches sent in from Sutter County, California. According to Sherbakoff, these three forms correspond to *F. asclerotium* (Sherb.) Wr., *F. solani* (Mart. p. part.) App. et. Wr., and *F. pirinum* Fries, respectively.

3. Inoculations with pure cultures of these three forms produced rot on fruit (peaches and oranges) and on peach and apricot buds under laboratory conditions, but failed to produce bud-rot on growing peach and apricot trees in the field under Berkeley, spring conditions.

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COLLEGE OF AGRICULTURE,
DIVISION OF PLANT PATHOLOGY

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THE CITRUS SCAB FUNGUS

ANNA E. JENKINS[1]

WITH FOUR FIGURES IN THE TEXT

The disease of citrus commonly known as scab is widely distributed geographically, and in Southeastern United States it is regarded as one of the most important diseases of this host (12, 18). It has also been reported recently on avocado by Stevens (13). While many of the etiological aspects of the disease are known, the systematic position of the pathogene has remained doubtful.

Scribner (12) was of the opinion that the Cladosporium which he found growing on the surface of the old lesions produced the disease. Swingle and

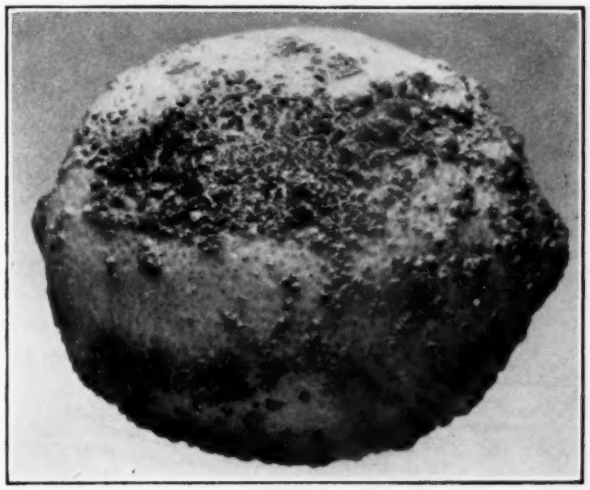

FIG. 1. Citrus scab on mature lemon. Natural size.

Webber (15) likewise attributed the disease to a Cladosporium of which they described the conidiophores and spores and recorded their measurements. Upon their description, which characterizes a true Cladosporium as typified by *Cladosporium herbarum,* Massee (10) based his diagnosis for *Cladosporium citri.*

The name *Cladosporium citri* Massee, therefore, applies to the fungus observed by Swingle and Webber on the old lesions. Accompanying Scrib-

[1] Paper presented at the annual meeting of the Botanical Society of America, Mycological Section, Washington, D. C., December 29, 1924.

ner's specimens which are now in the Pathological Collections of the Bureau of Plant Industry, is a note by Ellis, dated June 4, 1886, in which he wrote, "I do not think the *Cladosporium* belongs especially to the warts. The Cladosporii grow on all diseased parts." Grossenbacher (9) isolated a Cladosporium from the surface of old scab lesions with which he was unable to reproduce the disease. The writer has also isolated a Cladosporium-like fungus from the lesions; it may be that those referred to in the literature are of this type.

FIG. 2. Citrus scab on sour orange. Reduced. Photograph by J. R. Winston.

When Fawcett isolated the actual pathogene in 1906 (5), he reported it as *Cladosporium citri* Massee. Up to the present time this name has been almost universally used in referring to the citrus-scab organism. But the name as stated above refers to a Cladosporium which is evidently distinct from the fungus studied by Fawcett. In most of Fawcett's publications he states that the pathogene is not typical of the genus Cladosporium and

it is apparent that he realized it had no relation to the fungus found on the older lesions (6, 7, 8).

For the purpose of the present study, a single-spore strain of the citrus-scab organism was obtained from a culture isolated by Mr. H. E. Stevens in 1916. Greenhouse and field inoculations[2] of citrus leaves with this single-spore strain have reproduced the disease. Subcultures from this on various media under similar conditions were compared simultaneously with pure cultures of *Sphaceloma ampelinum* DeBary, isolated from typical anthracnose lesions on grape, and with subcultures of *Plectodiscella veneta* (Sacc.) Burkholder, the raspberry anthracnose fungus, grown from a culture contributed by Dr. L. K. Jones. Although the work is still in progress and has been confined largely to observations of growth in artificial media, the results indicate that these three organisms possess certain peculiar morphological and cultural characters in common, suggesting a close relationship. It is to be noted that as early as 1915 Shear's (14) attention was attracted to the similarity in culture of the grape and raspberry anthracnose fungi and at that time he suggested the possibility of their relationship. The parallel cultures show that the citrus fungus resembles *Sphaceloma ampelinum* more closely than *Gloeosporium venetum*, the imperfect stage of *Plectodiscella veneta*. Nevertheless the cultures appear to show that all three are distinct species.

The perfect stage of the raspberry anthracnose fungus is known (1, 2, 3). For the grape fungus for which DeBary (4) created the form genus *Sphaceloma*, Viala and Pacottet (16, 17) report extreme polymorphism, including a budding or yeast-like form which developed asci and ascospores. This ascigerous stage is very different from Plectodiscella, and as no other authors have reported it, a repetition of this work is desirable. As no perfect stage has been observed for the citrus-scab organism, it would seem best to classify it for the present under the hitherto monotypic form genus *Sphaceloma*. Since no technical name appears to have been given for the fungus, the specific name **fawcetti** is proposed. The description follows:

Sphaceloma fawcettii n. sp. (*Cladosporium citri* Faweett, not Massee). Acerculi solitary or confluent, subcircular, chiefly less than 1 mm. in diameter, on leaves intra-epidermal, becoming erumpent, pseudoparenchymatous at base, may also extend to the underlying host tissue, in this region mainly plectenchymatous; conidiophores arising perpendicularly from surface of stroma, standing close together, cylindrical, apex sharp pointed, blunt apiculate or obtuse, 1 to 3-celled, hyaline but may become dusky, principally 12 — 22 x 3 — 4 μ; conidia acrogenous, also pleurogenous (observed in culture), usually developed singly, often in succession from the same conidiophore (observed in culture), oblong-ellipsoid slightly reniform or ovid, ranging from 5 — 10 x 2 — 5 μ

[2] The field inoculations were made at Orlando, Florida, October, 1924, by J. R. Winston, Bureau of Plant Industry.

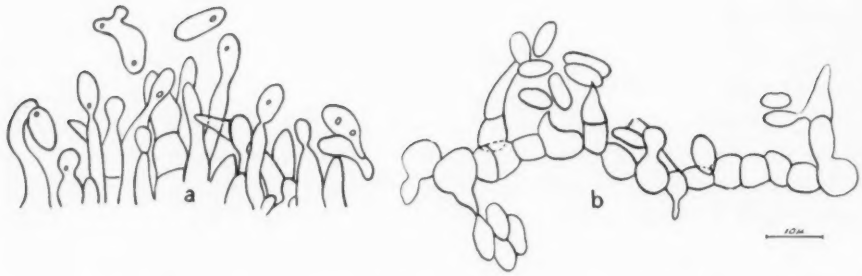

FIG. 3. *Sphaceloma fawcettii* from culture. *a.* Conidiophores and conidia developed on surface of stromatic growth on potato dextrose agar medium. *b.* Formation of conidiophores and conidia from mycelial strand.

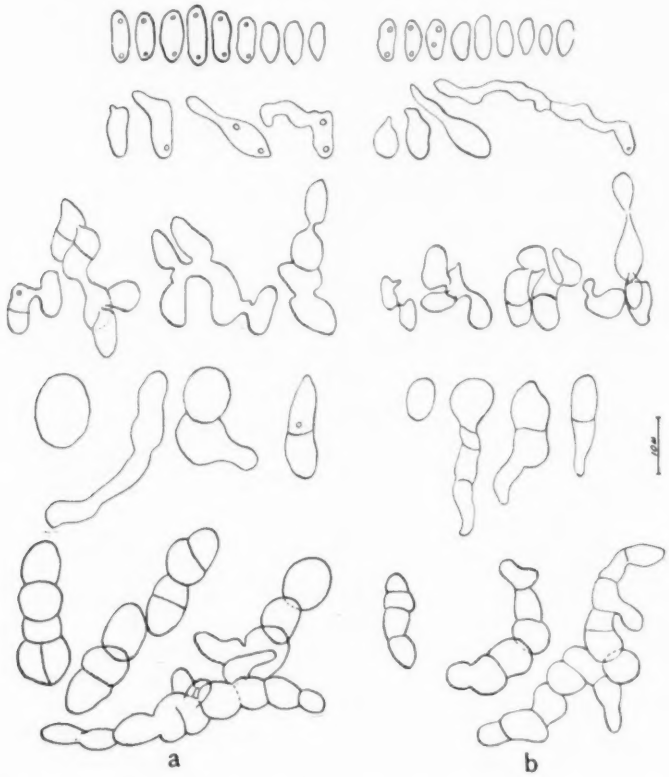

FIG. 4. Drawings to show relative dimensions and similarity of various germinated spores of the citrus scab fungus and the grape anthracnose fungus. *a. Sphaceloma fawcettii. b. S. ampelinum.* Developed in culture.

usually 6 — 8.5 x 2.5 — 3.5 μ, typically bi-guttulate one oil drop at each end, continuous, hyaline, sometimes becoming elongated or swollen and 1-septate, and dusky.

Distribution: On *Citrus aurantium* Linn., *C. grandis* (L.) Osbeck, *C. limonia Osbeck*,[3] producing rough, corky, wart-like projections commonly known as 'scab,' on twigs, leaves and fruits; lesions at first more or less translucent, green or tan, frequently becoming pink to brown at center, on fruit often becoming purplish. Florida, U. S. A. The disease known as scab has been reported from various citrus-growing regions of the world upon other hosts than those listed above.

Specimens examined:

On *Citrus aurantium;* Orlando, Fla., 1924, J. R. Winston, P. C. 9751 (Type); Ocala, Fla., 1886, P. C. 9749; Lake City, Fla., 1906, P. H. Rolfs and H. S. Fawcett, (F. Col. 2316), P. C. 9754; Bartow, Fla., 1900, H. H. Hume, P. C. 9755.

On *Citrus grandis;* Orlando, Fla., 1924, J. R. Winston, P. C. 9752.

On *Citrus limonia;* (artificial inoculation in greenhouse), Arlington Experiment Farm, Rosslyn, Va., 1924, A. E. Jenkins, P. C. 9753.

These specimens, as indicated by their accession numbers (P. C. No.), are to be found in the Pathological Collections, Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C.

Since it appears that the citrus-scab fungus is closely related to the anthracnoses of grape and raspberry, a correlation of the data on these three diseases is possible. Such a correlation might be of mutual aid in a further interpretation of the information in the literature on these three diseases and their causal organisms.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

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[3] The plants on which this fungus has been observed in Florida are listed in the paper entitled, "Susceptibility of some Rutaceous Plants and of Avocado Varieties to Attack by the Citrus Scab Fungus," by J. R. Winston, J. J. Bowman, and W. J. Bach, in Journ. Agr. Res. (In press.)

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EFFECT OF SOIL TREATMENT WITH SULPHUR UPON CROWN GALL IN NURSERY APPLE TREES

C. D. Sherbakoff

With Three Figures in the Text

Crown gall of apple in the nurseries of Tennessee and in the other southern states is recognized as a serious trouble. About three years ago the writer carried out an experiment in cooperation with two nurseries at Winchester, Tennessee, on the control of this disease by means of thorough sanitation. The scions and roots were thoroughly disinfected by dipping for 20 minutes in a 1:1000 solution of corrosive sublimate, after presoaking overnight, and then thorough rinsing in clean water. The grafts were made from the scions and roots over disinfected benches. The grafting knives and men's hands were also disinfected from time to time, and the grafts were stored in new boxes with new, clean sand. The grafts were of Early Harvest variety. The outcome showed[1] that in spite of these sanitary measures a very high percentage of the trees developed crown gall.

One of the cooperating nurserymen treated in the same way some of his grafts of the "Horse" and Yates varieties and reported, as a result of the treatment, considerably less crown gall in the Yates than he usually had in this variety.

The results of the experiment with Early Harvest alone indicate the ineffectiveness, or at least not a sufficient effectiveness, of the sanitary measures by themselves, and the conclusion is reached that the bacteria are present either in the scion (or root) or in the soil.

During 1922 and 1923, in cooperation with Mr. J. A. McClintock, the work was directed primarily along two lines: one to determine whether the infection in Early Harvest is carried internally, and whether there are some specimens of the variety that are free from such internal infection; and the other to test again the effect of the sanitary measures on crown gall development in Early Harvest as well as in several other varieties of apple trees. The work was done on the grounds of the Tennessee Experiment Station, at Knoxville, with a number of varieties of scion wood obtained from several different sources. Most of the grafts were made under sanitary conditions similar to those employed during the preceding year, as previously outlined. The writer with Mr. McClintock expects to publish in due time a detailed account of these experiments. For the present it is sufficient to

[1] The data were collected by J. A. McClintock.

say that out of the total of 2,320 one-year-old nursery trees of the Early Harvest variety grown, 413, or 18 per cent, showed true crown gall.

The above figures show about the same result as that of the preceding season, namely, an ineffectiveness of the sanitary measures. Judging from the fact that nearly all of the Early Harvest from different sources showed considerable crown gall, one is forced to conclude that the bacteria were probably present in the soil. Therefore it was decided to conduct a preliminary experiment on control of crown gall by a soil treatment.

The writer's observations and those of the nurserymen agree in that crown gall is worst under conditions of an abundant humus supply in the soil, especially where there is an application of barnyard manure, and where the soil is well supplied with lime—conditions similar to those which favor the common scab of Irish potatoes. The similarity goes farther. Both pathogenes—that causing the scab and the other causing crown gall—are intolerant of an acid reaction of the medium. The writer's previous experimental work with sulphur treatment of soil against the scab (See Cornell Bull. 350, Aug., 1914) suggested the same treatment for the control of crown gall.

A corner of the field on the grounds of the Experiment Station at Knoxville where infected apple trees were produced during the preceding season was selected for the experiment. Fifteen rows were laid off 3½ feet apart and about 100 feet long. Eight rows (every odd row) were left untreated as checks and seven rows (every even row) were treated with sulphur at the rate of 4.8 pounds per row, about 600 pounds per acre. The grade of sulphur was that which is known on the market as "inoculated sulphur." It was applied by hand evenly over a shallow furrow, about 3 or 4 inches wide, made with a hand plow. The furrow was covered with an attachment to the hand plow; then opened with the plow, then covered again with the attachment. This was done in order to have the sulphur well mixed with soil throughout a narrow strip where the grafts were to be set. The 600 pounds per acre was used because it appeared to be a sufficient amount to be effective on the particular piece of land and not too heavy to be injurious to the young apple trees. The sulphur was applied a week before the grafts were planted.

For this experiment, bench grafts were made on March 20 and 26, 1924, from root cuttings of commercial apple seedlings and from scion wood cut off from one-year-old nursery trees affected with well-developed crown gall at the union or on the scion wood. In making the grafts no sanitary precautions were taken and the scions and roots were not disinfected. The grafts were wrapped in damp sacks and stored in a cellar until April 7, when they were set in the field, in the sulphur-treated and untreated rows.

There were planted 1,575 grafts of Early Harvest, 270 of Red Delicious, 150 of Rome Beauty, and 111 of "Horse," each variety in a separate block across all of the fifteen rows and with as nearly the same number per row as possible. Owing to the poor condition of the root cuttings used in making the grafts, only about one-third of them rooted and produced normal trees.

The trees infected with well-developed crown gall, from which most of the scion wood was cut off for the making of the grafts for this experiment, were also planted in the sulphur-treated and untreated rows, at one end of the plot, nineteen trees per row.

From the beginning to the end of the season no difference between the trees grown in sulphur-treated and untreated rows could be detected, either in the stand of the trees or in their size. On November 3, 4 and 5, the trees were lifted and examined for crown gall.

The occurrence of crown gall infection on the nursery trees of the Early Harvest variety in the untreated rows was found to be as follows:

Row No.	Total trees	Trees showing true crown gall (Fig. 1)	Per cent
1	32	8	25.0
3	28	0	0
5	29	7	24.1
7	23	5	21.7
9	28	0	0
11	34	6	17.6
13	43	5	11.6
15	31	4	13.0
Total	248	Total 35	
Average per row	31	Average per row 4¾	Average 14.1

In the seven rows treated with sulphur the total number of the trees was 229, or an average of 32 trees per row. Here true crown gall was found on only one tree in row No. 2. Five trees, two in row No. 4 and three in row No. 14, were found with small, hard swellings at the union, as shown in Figure 2.

Of the Red Delicious variety there were 124 trees, two of which in the third row and one in the thirteenth row showed true crown gall. No crown gall was found in this variety in the rows treated with sulphur.

Of the Rome Beauty variety there were 41 trees, with true crown gall on one tree in the seventh, untreated, row.

Of the "Horse" variety there were 33 trees, of which true crown gall was found on one tree in the fourteenth row, treated with sulphur.

There were 285 of the two-year-old trees—those from which the scion wood was taken for the grafts. Examination of these trees showed that

most of them, both in the sulphur-treated and untreated rows, showed more or less noticeable enlargement of the galls, 46 per cent and 64 per cent, respectively; one of the largest galls is shown in Fig. 3. On some of the trees, 24.5 per cent and 19 per cent, respectively, the galls showed very slight enlargement; on others the galls evidently have not increased; and in a few cases, 8 per cent and 7.3 per cent, respectively, the galls apparently disappeared. There was no definite indication of any effect, either of the original crown gall or of the treatment, on the stand or on the vigor and

FIG. 1 FIG. 2 FIG. 3

FIG. 1. A small and hard swelling that in a few cases was found to develop in sulphur-treated rows on one-year-old trees of Early Harvest variety. No soil was adhering to the surface of these swellings. One-half natural size.

FIG. 2. A typical crown gall found in the untreated rows on one-year-old apple tree of Early Harvest variety. Some soil adheres to the surface of the gall when the tree is lifted even out of dry soil. One-half natural size.

FIG. 3. One of the largest crown galls found on two-year-old apple trees of Early Harvest variety. One-third natural size.

growth of these trees. Examination of the data obtained from the two-year-old trees shows that the treatment with sulphur may possibly have a somewhat retarding effect on the development of crown gall, although this is not certain. In this experiment fairly good sized holes were dug into which the trees were set. Owing to the digging in most cases very little or no sulphur was in a direct contact with the crowns of the trees and to this fact may be ascribed the slight, if any, effect of sulphur upon the crown gall.

From the data obtained with the one-year-old trees, it is evident that except in the case of Early Harvest there was not enough crown gall development on the trees grown in the untreated rows to admit of a conclusion in regard to the effect of the treatment upon the disease.

In the case of Early Harvest, however, the evidence is strong that the treatment is very effective in the control of the disease. Although the number of trees affected with true crown gall in the checks is not large, it is sufficient to be of definite significance when one considers the practically total absence of the crown gall in the treated rows.

Final proof, as well as many other factors of practical importance in connection with crown gall control by means of soil treatment with sulphur, such as the effective minimum application for various soils, methods of application, and the like, is, of course, to be obtained from further experiments.

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ROOT-ROT OF PEAS IN THE MIDDLE ATLANTIC STATES IN 1924

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During the spring of 1924, the writer participated in a survey of some of the pea-growing districts in Maryland, Delaware and New Jersey, the object of which was to ascertain the prevalence of root-rot and more particularly the relative importance of a number of parasites to which major damage had been ascribed. A season more favorable for such inquiry could scarcely have been chosen. An unusually wet April was followed by an excessively wet May, and that in turn by a June with a rainfall well above the normal. As May probably includes the period most important in the development of pea-root troubles in the region under consideration, the following passages in the meteorological reports from the Maryland and Delaware section, and from the New Jersey section, respectively, descriptive of the weather conditions prevailing during that month, may be of interest:

"May was markedly cool and unusually wet. . . . The average rainfall, 6.44 inches, was one and four-fifths times the normal and the greatest of record in May since 1889."[1]

"Subnormal warmth and excessive rains, which prevailed in April, continued throughout May, so that weather conditions, relatively, assumed an unprecedently unfavorable aspect. The low temperature, the amount and frequency of rain and consecutive cloudy days have rarely been equalled singly, and never in combination. It has probably been the worst spring since 1886, which was also cold and damp."[2]

Observations were begun May 15 in Talbot County, Maryland, where the more advanced fields had been blossoming for several days. Fields in Queen Anne County were visited the following day. On May 27 and May 28, inspections were made in a number of localities in Sussex County and Kent County, Delaware; and continued on May 29 in Cumberland County and Camden County, New Jersey. The survey was concluded in Carroll County, Maryland, on June 11, the crop here being well advanced, at a stage preceding readiness for harvest by about two weeks. With the exception of experimental plots near Cedarville, N. J., and at Arlington Farm, Va., as well as of a number of fields in Anne Arundel County, Maryland, devoted to the cultivation of fresh peas for the city market, all the tracts inspected were planted to peas apparently of the Alaska type.

[1] Spencer, J. H. General Summary. Climatological Data. Maryland and Delaware Section. 29: 17. 1924.

[2] Noyes, G. H. General Summary. Climatological Data. New Jersey Section. 29: 17. 1924.

The principal forms of root disease were found represented in one or more fields in each locality visited. An infection of the type attributed by Jones[3] to the fungus described as *Fusarium martii* App. & Wr. var. *pisi* occurred rather widely, but at the same time quite sparingly. It was the only root infection found, for example, in a plot at Arlington Farm never before planted to peas, and was manifested here as a vascular trouble, the cortical tissue surrounding the woody core with its reddish brown discoloration, not being visibly decayed. By June 6, after the advent of warm conditions, the scattered individual plants attacked had stopped growing, their foliage was of a sickly yellow color, and incipient symptoms of wilting were becoming evident. Members of the genus Fusarium were richly represented also in isolations made from the greatly softened cortex of roots bearing an abundance of oospores of a fungus recently described[4] as *Aphanomyces euteiches* Dr., but their occurrence, under such circumstances, did not appear strikingly indicative of a parasitic relation.

In regard to species of Pythium, a very similar condition obtained. More than a hundred isolations referable to the genus were made, each from a different collection of diseased plants, except in such instances where the same collection yielded growths obviously belonging to separate species. From 6 to 8 distinct species are recognizable in the assortment, which will receive taxonomic treatment later in a more comprehensive account. At least 3 of these species represent types ordinarily encountered by the pathologist, and customarily referred to *Pythium debaryanum* Hesse, being distinguished by abundant aerial mycelium in culture, smooth oogonia, and subspherical sporangia or conidia. Over a score of isolations represented types with spiny intramatrical oogonia and poorly developed aerial mycelium, falling into 2 or 3 species referable to Artotrogus, a group usually regarded as a subgenus, but perhaps not undeserving of generic rank.

Although some isolations were made from discolored rootlets not showing evidence of being attacked by any other fungus, the most prolific source for cultures of species of Pythium was found in the cortical tissues of the stem and larger roots bearing the oogonia and oospores of *Aphanomyces euteiches*. In fields in which the latter fungus was common, the genus Pythium appeared to be found occurring more abundantly in secondary relationships than in directly parasitic ones. This condition is apparently not due to any lack of potential virulence, since nearly all of the smooth forms tried out so far, as well as one spiny form, which was derived from material col-

[3] Jones, F. R. Stem and root-rot of peas in the United States caused by species of Fusarium. Jour. Agr. Research **26**: 459–476. Illus. 1923.

[4] Jones, F. R., and C. Drechsler. Root-rot of peas in the United States caused by *Aphanomyces euteiches* n. sp. In press; to appear in Jour. Agr. Research.

lected at Hamburg, N. Y., attack cucumber fruits with great readiness—generally, a fair index of a moderate degree of pathogenicity. The remaining spiny species, on the other hand, fail to attack cucumbers, but, with one exception, are capable of developing in watermelon fruits when inoculated under the rind, such development requiring, in general, a relatively low degree of virulence. The widespread occurrence of even the most aggressively parasitic species of Pythium in dead organic matter has long been recognized, and it is evident that the tissues killed by *Aphanomyces euteiches* provides a more congenial substratum than the living parts.

Mycelium of *Corticium vagum* B. & C. var. *Solani* Burt (*Rhizoctonia solani* Kühn) was frequently encountered in the softened cortex of diseased stem or main root. In most instances its occurrence, in conjunction with an abundance of oogonia of *Aphanomyces euteiches* gave grounds for regarding also its role more that of a secondary invader than of a primary parasite. Occasionally, to be sure, lesions of the type characteristic of its parasitism were found in the field. The fungus was not found to be regularly associated, however, with a very common but relatively innocuous condition, resulting from partial or complete decay of the cotyledons, which decay frequently extended a short distance over the adjacent portions of root and stem as a corrosion of the cortex.

Aphanomyces euteiches was found to be incomparably the most important primary cause of root-rot. In approximately one-fourth of the fields visited, infection by this Saprolegniaceous parasite was so thoroughgoing that not a single healthy plant could be located even when special search was made for individuals that might have escaped the disease. The underground parts of every plant were found involved in characteristic softening of the cortex, and, on some sandy soils, where the vines had become somewhat prostrate, the destruction of cortical tissue extended several centimeters up the aerial portions of the stem. Fields thus affected were readily recognized at a distance by the pale yellow color of the foliage. Microscopic examination revealed the oogonia and oospores characteristic of the parasite in the softened cortex of all underground parts large enough to be conveniently removed from the soil.

In approximately one-half of the fields inspected, the disease due to *Aphanomyces euteiches* was found in more moderate quantity, frequently being present in severe form only in situations unduly wet as a result of inadequate drainage or proximity to watercourses. To a considerable extent, its distribution appeared quite fortuitous, badly infected individual plants being intermingled in stands that were largely healthy. In the remaining fields, representing about one-fourth of the entire number visited, root-rot was either entirely absent, as far as could be determined, or present

only in very small quantity. This condition was typical generally of land which had not been planted to peas before, or which was known not to have been in peas for many years. Here the diseased specimens could be located only by carefully searching for yellow vines, occurring singly here and there, or, perhaps, in widely scattered groups of two or three.

Some of the instances of extreme or very heavy infection could readily be related to a patent lack of proper rotation, as, for example, where fields had been planted to peas 3 or even 7 years in succession. As the necessity for rotation is quite generally understood by the majority of growers, such cases were not found especially frequent. In certain localities, where a 5-year rotation is being practised, 2 successive crops of peas are scheduled to follow 3 successive crops other than peas. A number of fields thus cropped to peas were among those showing extreme or very heavy infection. In one instance extreme infection was found in a field, which, according to information supplied by the owner, had not been planted to peas in recent years, but had been fertilized with vines from other fields. In general, the evidence appeared to indicate that while in most types of soil 3 years constituted a sufficiently long interval to permit the growing of a single crop of peas without much damage from root-rot, it was not altogether adequate where a second crop of peas was to follow the first, at least in seasons as favorable for the disease as that of 1924. A further reduction of the residual contamination of the soil with *Aphanomyces euteiches* by extending the period devoted to crops other than peas to 4 or 5 years, might prove advisable.

The influence of type of soil on the various manifestations of root-rot is not readily determined by observations of a single season. The destruction of cortex appeared to extend further up the stem above the ground line on loose open soil than on heavier compact soil. The centrifugal distribution from the original foci of infection would seem to progress more slowly in dense soil. Thus in the plot at the experimental substation at Ridgely, Maryland, the soil of which is of a less open texture than the soils usually devoted to pea-growing, the areas exhibiting root-rot in 1924 were found to correspond closely to similar areas observed in the previous season, the increase in size not being marked. It may be mentioned in this connection that most of the fields showing extreme infection were on the more porous types of soil. Although it is not difficult to understand why the open types of soil should be better adapted to the spread of the zoospores of the parasite, the distribution of the fungus on a larger scale could scarcely be effected directly by locomotion of the zoospore alone. On the other hand, seepage through the superficial layers of soil, or slow surface drainage of water abounding with swarm spores, such as might readily have occurred, for

example, during the wet spell from May 8 to May 12, might provide means much more effective in distributing the fungus in porous soil than in compact soil.

Although the disease due to *Aphanomyces euteiches* occurred with more than usual severity, losses from this source were not as heavy as might have been expected. As is well known, diseased plants continue to develop in spite of the virtually decorticated condition of the underground parts as long as an ample supply of moisture is available in the soil, the reduced efficiency of the root system being expressed chiefly in the yellowish, sickly appearance of the vines. The worst effects do not show until dry conditions intervene, when the diseased root systems fail to maintain transpiration with the result that the plants wither and die. Owing to ample, well-distributed precipitation during the month of June, such wilting was prevented this season—an instance of the most destructive phase of a disease being obviated by a continuation of the very conditions that had encouraged its inception.

While, to be sure, the crop on the whole was not an unsatisfactory one, owing largely to fortunate weather conditions obtaining during the latter part of May and throughout June, the writer believes that the prevalence of the Aphanomyces disease brought about a material decrease in yield. Where the trouble appeared early and in extreme degree, the obvious reduction in vegetative vigor could scarcely have made for a maximum production of pods. In one known instance, a field so completely infected by May 15 that no healthy individual plant could be found, showed up so lacking in promise a few weeks later, that the vines were plowed under. Although this case may not be typical, it illustrates a kind of economic loss associated with the disease, quite apart from the more drastic loss brought on by intervention of droughty conditions.

Evidence that root-rot was present in the pea-growing districts north of Maryland and New Jersey, was provided by specimens of diseased peas sent to the Plant Disease Survey, which the writer had occasion to examine. Oogonia and oospores characteristic of *Aphanomyces euteiches* were demonstrated in variable quantity in almost all the material, thus establishing the presence of the parasite at New Haven, Connecticut; at Eden, Hamburg and Mt. Morris, in the eastern part of New York; at Mineola, on Long Island; and at Aspers, Drifton and State College, in Pennsylvania.

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A MARASMIUS PARASITIC ON SMALL GRAINS IN ILLINOIS

P. A. YOUNG

WITH FIVE FIGURES IN THE TEXT

While collecting data and specimens for the Illinois State Plant Disease Survey during the summers of 1923 and 1924, the writer found small mushrooms attached to the stems of wheat, rye, barley, quack grass, and an undetermined grass. At Abingdon, in central Illinois, an area of a few square rods in one wheat field showed mushrooms attached to half of the stalks. In all cases observed, the sporophores were attached within two inches of the surface of the ground as shown in Figure 3. The other collections consisted of only a few mushrooms each. The culms of the quack grass were green when the mushrooms were collected on them. The small grains were ripening and the mushrooms on them had dried up when the specimens were collected. No evidence of injury to crops was seen.

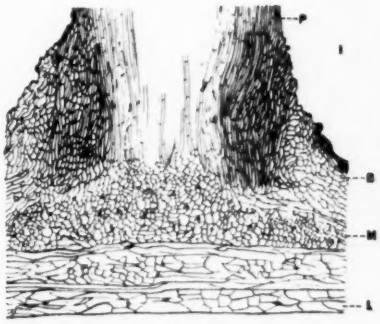


FIG. 1

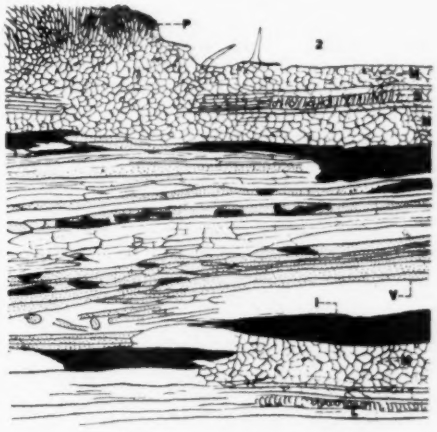


FIG. 2

FIG. 1. Section through base of stipe showing attachment to leaf sheath. P, thick-walled prosenchymatic cells of stipe, thin-walled cells inside. B, brown, unstained cells in base of stipe. M, mycelium and disintegrating host cells; black spots represent thick fragments of purple-stained hyphae. L, inner side of leaf sheath. Slightly diagrammatic. × 100.

FIG. 2. Section through wheat stem showing mycelium around base of stipe and near the culm cavity. P, thick-walled prosenchymatic cells of base of stipe. M, mycelium and disintegrating host cells. S, spiral trachea. V, pitted tracheae. I, indefinite and broken cells, mostly pitted tracheae. L, inner layer of cells next to culm cavity. Slightly diagrammatic. × 40.

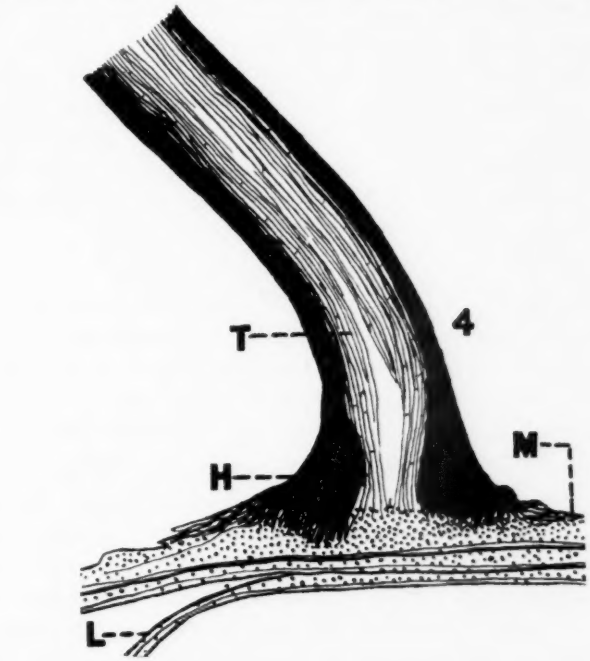
Though Cobb (1), Fulton (2), and Johnston(3 and 4) report species of Marasmius and some other agaries on sugar cane, the only published records of agaries occurring on small grains in the central part of the United States that the writer has seen are two brief notes by Tehon (5, 6) in which he reports the presence of the fungus considered here. Mushrooms parasitic on chlorophyll-containing tissues are comparatively rare.

FIG. 3. Photograph of Marasmius sporophores attached to bases of wheat stems. × about 1½.

A characteristic dry piece of wheat culm bearing several mushrooms was soaked in lacto-phenol fixer for 3 days, imbedded, sectioned, and stained with Pianeze III B. The sections showed the mycelium deep in the host tis-

sues (Fig. 2). A section of a young sporophore which had not yet broken through the epidermis is represented in Figure 5.

The five figures show the origin and attachment of the sporophores.



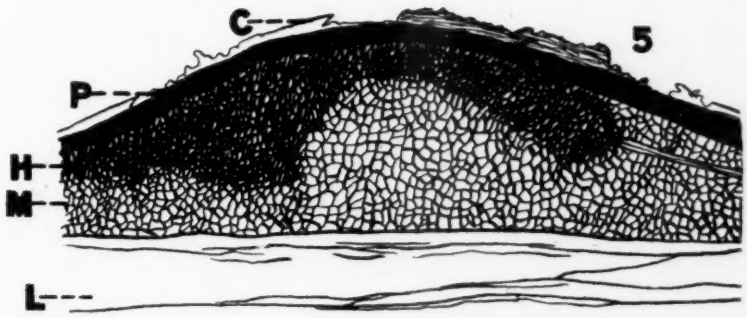


FIG. 4. Lower part of stipe showing swollen base and attachment to leaf sheath. T, thin-walled prosenchymatic cells. H, thick-walled prosenchymatic cells. M, mycelium. L, lower side of leaf sheath. Diagrammatic. × about 55.

FIG. 5. Early stage in the development of a young sporophore; not yet broken through the primary cortex, P. C, cuticle. H, thick-walled prosenchymatic cells. M, mycelium. L, lower cells of sheath. Diagrammatic. × about 135.

Note. All drawings from longitudinal sections through wheat stem. All outlines made with projection machine.

Only traces of the host tissues stain green and remain distinct below the sporophores. They are usually entirely decomposed and their space occupied by fungous tissues. Judging from the appearance of the sections, the mycelium must have developed while the host was still green.

Since this fungus does not agree with the descriptions of any of the species of Marasmius given in Volume 9 of the North American Flora, it is described as a new species. Only a small number of spores was seen. *Marasmius androsaceus* (L.) Fr. in Roumeguère's Fungi selecti exsiccati No. 6943 (species No. 153 in Vol. 9 of the N. A. F.) resembles the new species most. It is a saprophyte on fallen leaves in woods. The new species is described as follows:

Marasmius tritici, n.sp. Figs. 1–5.

Pileus membranous, convex to campanulate, depressed at center, 2–7 (usually 3–4) mm. broad; surface ocraceous to ferruginous, slightly pulverulent, margin distinctly sulcate; lamellae adnate to collar, slightly decurrent on collar, equal, whitish; spores 6–7 × 3–4 microns; hymenium layer 10–25 microns wide, basidia 3–4 microns wide; stipe brittle and sulcate when dry, dark brown, glabrous, shining, 2–4 cm. long and 0.3–0.5 mm. in diameter, hollow. Parasitic on culms of *Triticum vulgare* L. (smooth, red fall wheat), collected at Abingdon, Ill., July 12, 1924. Type specimen is No. 18116 in the herbarium of the Illinois State Plant Disease Survey and in the herbarium of the University of Illinois. Other collections are: No. 17332 on Red Wave wheat, Worden, Ill., 6–19–23; No. 17832 on *Secale cereale* L., Savanna, Ill., 7–16–24; No. 18060 on *Hordeum vulgare* L., (six-row barley), Wheaton, Ill., 7–31–24; No. 18198 on *Agropyron repens* Beauv, Wheaton, Ill., 7–31–24; and No. 5779 on an undetermined grass, Ridgway, Ill., 6–12–24.

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WATERMELON INTERNAL BROWNING

W. W. Gilbert and Ernst Artschwager

With Five Figures in the Text

An interesting case of internal browning in watermelons, apparently comparable with the internal brown-spot of the potato and the Baldwin spot of the apple, was recently brought to our attention by Mr. Wm. E. Lewis, Assistant Marketing Specialist of the Bureau of Agricultural Economics. The melons in which the trouble was found were grown at Burroughs, Ga., and constituted about 5 per cent of the crop on an area of about 225 acres.

Instead of the areas of dead, brown, pithy cells being scattered through the entire fruit as is the case with the apple and the potato troubles, they are confined to a peripheral ring one-fourth to one-half inch or more in width in the rind beginning about one-eighth to one-fourth inch inside the skin of the melon, as shown in the accompanying photographs of cross-sections of parts of affected melons (Fig. 1, a and b).

The first indication of this condition is exhibited by small rounded or irregular diseased areas which, at first only watersoaked in appearance, soon become pithy and discolored. In mild form, the spots are separate and have a diameter of one-eighth to one-half inch; in severe cases they form an almost continuous layer of brown tissue one-fourth to one-half inch or more in thickness and extending around the entire melon. Where the injury is most pronounced, there appears on the outside of the melon a coarse mottling or dotting of rather bright yellow, rounded spots one-half inch or more in diameter scattered over the normal green of the Tom Watson melon.

The melon rind, which is the seat of the injury, consists of an epidermis, a cortex, a sclerenchymatous cylinder and the peripheral tissue of the fruit flesh (Fig. 1, c). The epidermis is single-layered and topped by a heavy cuticle which extends inwardly between the anticlinal walls of the epidermal cells. Next to the epidermis is a narrow cortex about .2 mm. in width. The cells comprising this layer are small, thin-walled and somewhat flattened tangentially. The innermost layer of these cells abuts abruptly on the sclerenchyma sheath. The latter is composed of four or five layers of small irregular cells which are strongly lignified and perforated by numerous simple pits. The transition from sheath to the peripheral tissue of the fruit flesh is less abrupt than that between cortex and sheath. The cells grow perceptibly larger and elongated in the radial plane. Embedded in the peripheral tissue of the fruit flesh are small collateral bundles, the extremities of the vascular bundle system of the melon.

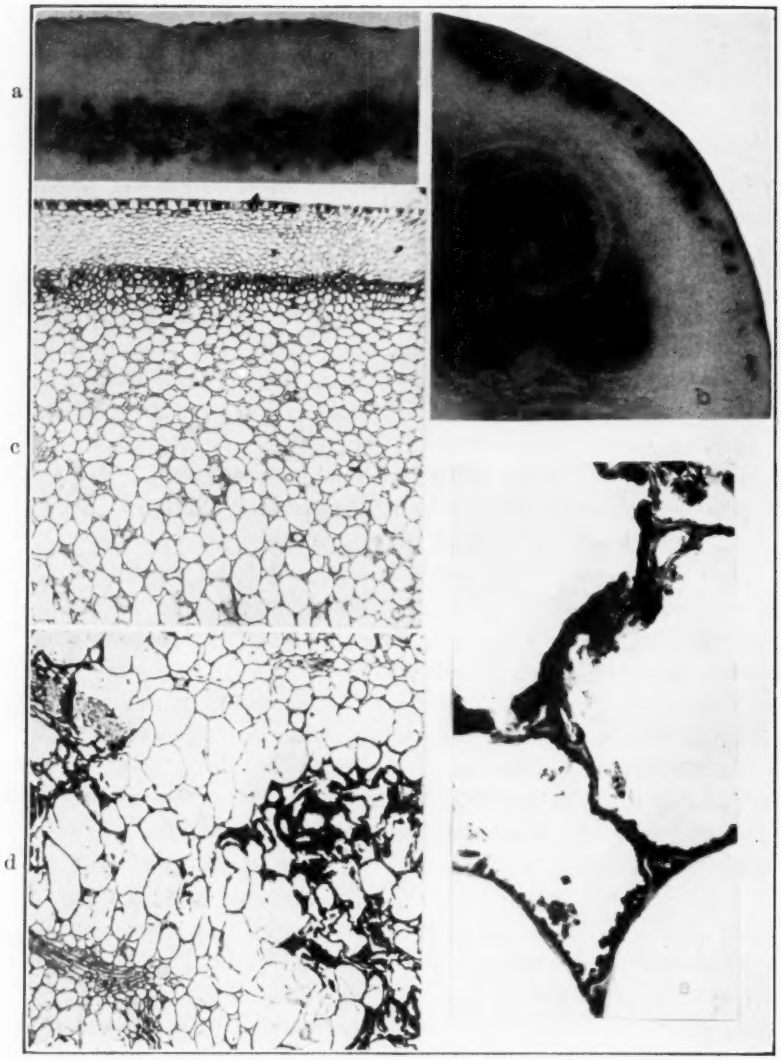

FIG. 1. a. Section through melon rind showing band of necrotic tissue.—b. Section through melon showing relation of diseased tissue to the melon as a whole.—c. Cross section through melon rind showing epidermis, cortex, sclerenchymatous cylinder and peripheral fruit flesh. × 56.—d. Cross section through peripheral fruit flesh showing necrotic areas. Notice that the vascular bundles are normal. × 56.—e. Enlarged view of necrotic cells. × 400.

The diseased areas described above develop in the peripheral fruit flesh or inner part of the rind. The injury is confined to the parenchyma (Fig. 1, d); the vascular bundles always appear normal, unless by chance diseased parenchyma cells border directly on a vascular bundle. In the early stages of the disease, exhibited by the water-soaked condition of the tissues, the walls of the cells are already partly or entirely lignified. Lignification is evident at first in the middle lamella and only later the entire wall and content become affected. The walls appear swollen and lamellate especially in the region of the intercellular spaces. The latter become filled with a granular content which is later also seen in the lumen of the cells (Fig. 1, e).

In advanced stages, when discoloration becomes visible to the naked eye, the cells of the diseased areas have collapsed. Both walls and content have a brownish color characteristic of necrotic cells. In the specimen tested there was no apparent deleterious effect on the flavor of the melon, although it is quite probable that the marketability of such melons is impaired.

The cause of this abnormal condition has not been determined, but a period of four or five weeks of very dry weather which occurred while the melons were maturing is thought to have had some relation to the trouble.

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RHIZOPUS ROT OF PEACHES

H. W. ANDERSON

Brown rot of peaches has long been regarded by pathologists and orchardists as the only important rot in the orchard and in transit. Those handling the fruit in market are usually not sufficiently acquainted with diseases to distinguish the various types of rot. Consequently rejections of the fruit by commission men is usually attributed to brown rot. The inspectors of the Bureau of Agricultural Economics, however, distinguish between brown rot and Rhizopus rot and it is interesting to note that Rhizopus rot is very frequently the only rot reported by the inspectors.

Recently, I looked over the reports on peaches of the Bureau of Agricultural Economics for the state of Illinois, *i. e.*, of shipments originating in this state. The markets where the inspections were made were widely separated and included such cities as Milwaukee, Minneapolis, St. Louis, Detroit, Columbus, O., Memphis, Cleveland, Cincinnati, Pittsburgh and Kansas City. This wide distribution eliminated the error of one inspector being more familiar with this particular disease and thus favoring it during inspection. The inspections include three years, 1922, 1923 and 1924. The result of the tabulation was very surprising to me.

TABLE 1.—*The frequency of peach rots in shipments of peaches from Illinois*

Year	Total no. cars	No decay	Rhizopus rot	Brown rot
1922	50	19	20	21
1923	29	8	15	13
1924	25	9	9	7
Total	104	36	44	41

This table shows that Rhizopus rot was reported more frequently than brown rot and, since it is more destructive than brown rot, the loss from Rhizopus rot in transit, storage and market is probably much greater.

Inspection of peaches on local markets during the last three or four years has convinced the writer that Rhizopus rot is more frequently present and more to be feared than brown rot. The fungus (*Rhizopus nigri-*

cans) travels with great rapidity through the baskets, especially in the bottom, and attacks both injured and uninjured fruit. The mycelium penetrates the flesh very rapidly, resulting in complete decay within a day or two. For example, four bushels of sound Hale peaches were shipped from southern Illinois and left in a cool room for two days. They were in transit (express) one and a half days. At the end of this period (three and a half days) 30 per cent of the peaches were rotted. All the diseased peaches were removed and the healthy ones were placed in a clean basket. At the end of two days the peaches were again examined and fully half were more or less rotted. The fungus had produced enormous quantities of mycelium which had grown not only over the peaches but over the inner surface of the basket and in the spaces between the fruit. Wherever it came in contact with the surface of the peach the skin showed numerous small watery spots where decay had started.

Ordinarily this rot is not a serious factor in the orchard, but during the past season, an unusually wet one, several reports were received of serious damage to fruit on the trees. The growers were alarmed because they were not familiar with the fungus. In these orchards perfect control of brown rot had been secured by the use of dry mix lime and sulfur, but this treatment had not controlled the Rhizopus rot. The prevalence of this rot in the orchard may in part be explained by the fact that cracked fruit, due to weather conditions, was unusually abundant in most orchards this season.

The relation of temperature to the development of this rot is interesting and may indicate a possible method of control. Harter and Weimer[1] have studied the effect of various temperatures upon the germination of the spores and the growth of mycelium of *Rhizopus nigricans*. They show that growth is very limited below 7° C. (47° F.), but that at 15° C. (57° F.) growth is very rapid. It is evident that little loss would be experienced in transit provided the temperatures could be kept low enough, but this is quite difficult. Inspectors report more decay at the top of the car load and near the door than in other parts of the car. Since the temperatures at these points are usually four or five degrees above those of other parts, it is evident that a rise of a few degrees makes considerable difference in the amount of Rhizopus rot. The temperature at the top of the load averages nearly 47° F. according to the reports of the inspectors. This is probably near the minimum temperature of the car in transit since the fruit is loaded

[1] Harter, L. L., and Weimer, J. L. Some physiological variations in strains of *Rhizopus nigricans*. Jour. Agr. Research **26**: 363–371. 1923.

Weimer, J. L., and Harter, L. L. Temperature relations of eleven species of Rhizopus. Jour. Agr. Research **24**: 1–40. 1923.

warm and the temperature of the car decreases gradually until it reaches its destination. After the fruit leaves the car, unless it is immediately placed in cold storage, the temperature increases rapidly and soon approaches the optimum for the development of *Rhizopus nigricans*. It is evident, therefore, that while the low temperature of the refrigeration car materially retards growth, at no time is the temperature below the minimum for the germination of the spores and the growth of the fungus. A more rapid cooling of the fruit and care in icing the cars may aid materially in reducing the amount of damage.

It is the opinion of the writer that more attention should be given by pathologists to this rot and a study should be made of methods of control in transit and storage. Brown rot in properly sprayed or dusted orchards is no longer a serious factor under Illinois conditions, but great losses are being experienced on account of Rhizopus rot in transit and market.

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ABSTRACTS OF PAPERS PRESENTED AT THE EIGHTH ANNUAL MEETING OF THE PACIFIC DIVISION OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY, PENTICTON, BRITISH COLUMBIA, AUGUST 26 TO 29, 1924

SYMPOSIUM

Virus diseases and their relation to potato seed certification. Discussion led by B. L. RICHARD, Utah; B. F. DANA, Washington; J. W. EASTHAM, British Columbia, and C. W. HUNGERFORD, Idaho.

Physiology of zoospore formation among certain species of Phytophthora. F. B. COTNER.

Witches broom of potatoes. B. F. DANA and C. W. HUNGERFORD.

Sunflower wilt. H. E. MORRIS.

Evaluation of loss from killing diseases in young forests. E. P. MEINECKE.

Detection of spoilage in berry products. CARL R. FELLERS.

Water core in apples. D. F. FISHER.

Black rot and Myxosporium canker of apple and pear in the Pacific Northwest. S. M. ZELLER.

Investigative work on white pine blister rust in the Pacific Northwest for 1923. J. S. BOYCE.

During 1923, circumstantial evidence was such that for practical purposes it must be concluded that blister rust can spread directly from western white pine to Ribes, a distance of 110 miles, and probably much farther. Numerous infections on *Ribes nigrum* were found in the interior of Washington and British Columbia many miles from the nearest 5-needle pines, and infection was present on *Ribes bracteosum* at Namu, and *Ribes nigrum* and *Grossullaria divaricata* at Bella Bella, on the coast of British Columbia, 80 and 110 miles, respectively, north of the known range of 5-needle pines. So far it has been impossible to obtain any conclusive evidence of the disease overwintering on Ribes.

The development of the rust on Ribes served to emphasize the extensive importance of *R. nigrum* in the distribution and spread of the disease. This species is by far the most highly susceptible occurring in the Northwest. At long distances from pine infections and where climatic conditions are less favorable to the development of blister rust, as in the interior of Washington and British Columbia, initial infection was practically confined to *R. nigrum.*

Some facts about Loganberry "dwarf." S. M. ZELLER.

This disease, which has many of the symptoms of bramble streak as found in blackberries in the East, is characterized by short internodes of the canes, several small buds at each node, and small, slightly yellowed, obovate leaflets. Streaking of the canes has never been observed. Transmission of the disease has not been demonstrated, but evidence shows that the disease is not propagated by layering, for affected tips do not root.

A case of Verticillium wilt (Blue Stem) of black raspberry in Oregon. S. M. ZELLER.

One acre of 3-year-old Plum Farmer black raspberries on land planted to potatoes the year before had about 52 per cent of the plants dead or dying during the late fall of 1923–24. Mungers on the same soil which had not been in potatoes were doing well after

five years. Cultures of a strain of *Verticillium alboatrum*, Reinke and Berth, were obtained from 49 out of 51 of the affected Plum Farmer plants.

A preliminary report of the uredinales of Washington. J. W. HOTSON.

This article, which will appear shortly in the Biological Publications of the University of Washington, is an annotated list of the rusts of the state of Washington. It is based on over 2,000 collections made in various parts of the state. These are distributed among nearly 200 species.

Since many of the collectors of Washington rusts do not reside in the state, it is highly probable that many collections have been omitted from this preliminary list. For this reason a supplementary list will be published as soon as the number of new collections will warrant it. If this report should come to the notice of any person who has made collections in any part of the state of Washington, the author will be glad to receive samples of such collections.

Serious blossom blight in Pacific Northwest orchards due to a species of Monilia. H. P. BARSS.

Much economic loss is annually experienced in orchards of Western British Columbia, Western Washington, Western Oregon and perhaps farther south due to the blighting of blossoms and killing of spurs, accompanied sometimes by cankering and girdling of smaller branches and twigs and followed by a negligible amount of fruit rot caused by a species of Monilia similar to *Sclerotinia cinera* (Bon.) Wor. but, in the view of the author, distinct from the latter because of its different life-history, growth characters and spore morphology. The fungus was first studied some years ago by Mr. G. B. Posey under the direction of the author, in an investigation, the results of which appear in an unpublished thesis. The name *Monilia oregonensis* Barss and Posey has been assigned to it. Apricots, sour cherries, sweet cherries, prunes, peaches and pears are the principal hosts. Quince and apple fruit has been found infected. The fungus winters in the blighted parts, producing olivaceous spore-tufts in winter and spring. Apothecia are unknown and could not be produced by the conditions favorable for apothecium formation in *Sc. cinerea*.

Plant pathology in California. RALPH E. SMITH.

California is quite unique in its diversity of natural conditions and the variety of its crops. Most of its agriculture is carried on under rather artificial conditions. Numerous major plant disease problems occur, many of them still entirely unsolved. Probably all of the usual fungus diseases of the important crops of California have been introduced, but many of them are unknown or of minor importance on account of the rainless summers. Excellent control of such troubles of this sort as attain economic importance is quite uniformly obtained. The more serious phytopathological problems are to a large extent of two other classes.

1. Apparently, or so-called "physiological" disorders of a very specific nature. Typical examples, "blossom end rot" of tomato; "black end" of pear; "little leaf" of deciduous fruits and other trees; "tip burn" of lettuce; "exanthema" of many trees. Many or all of these show an apparent relation to soil moisture and nutritional conditions and no evidence of parasitism. Some of these diseases are discussed.

2. Troubles in which a specific parasite probably occurs, but where parasitism depends largely upon obscure environmental factors. Examples discussed.

Results of experiments in 1924 with various chemical dusts for smut control in wheat. H. P. BARSS.

Fall planted rod row tests with heavily smutted wheat (1 part spores of *Tilletia tritici* to 77 parts of grain by weight) using various samples of chemical dusts thoroughly applied at the rate of 2 ounces per bushel showed that the best control was obtained by brands of copper carbonate of standard fineness containing 50 per cent or more of copper, that next in efficiency were the types of copper carbonate containing 17 to 21.5 per cent of copper followed by Seed-o-San, Semesan and Corona 620, all organic mercury compounds. Nickel carbonate was much less effective. Furfural (1 to 400) used as a dip proved entirely ineffective. Two mercury compounds proved utterly valueless applied as a dust. Complete smut control was not obtained in the case of any material used on wheat smutted at the 1 to 77 rate, yet with wheat smutted at the rate of 1 to 500, high grade copper carbonate at 2 ounces per bushel gave complete smut control, while none of the other dusts gave less than 23 per cent smut heads under similar conditions. At 1 to 1,000, however, copper carbonate with 50 per cent copper, copper carbonate with 21 per cent copper and Semesan all gave complete or practically complete control.

Conclusions from four years' tests of various methods of seed treatment for bunt control in Idaho. CHAS. W. HUNGERFORD.

Extensive field tests carried on in cooperation with farmers in northern Idaho as well as numerous plot tests have shown that copper carbonate dust of standard fineness and containing at least 50 per cent copper, applied at the rate of two ounces to the bushel, has not given as good control as the standard bluestone and salt treatment. Three ounces to the bushel have given nearly as good results as bluestone and salt. Copper carbonate dusts, containing less than 50 per cent copper, were not so effective unless used in larger amounts. Semesan, four ounces to the bushel, was as effective as copper carbonate at three ounces. Three ounces of nickel carbonate was not so satisfactory.

Experiments for the control of bunt in spring wheat in 1924 showed that copper carbonate (six different brands used both two and three ounces to the bushel), Corona 640, Corona 640S, semesan dust and semesan and uspulun liquid treatments reduced the amount of smut to less than one per cent in each case while the checks developed over 12 per cent. Furfural of various concentrations gave practically no control and its use resulted in very serious injury to germination.

The application of certain organic mercury compounds in plant pathology. GEO. H. GODFREY.

The organic mercury seed disinfectants were initiated in Europe about twelve years ago with the development of uspulun, a compound of the coal tar product phenol, with a salt of mercury. Its superiority over the inorganic salts as a disinfectant in the field of agriculture became immediately evident, and a great deal was written regarding it in the European literature. Its introduction to America was delayed only by the war. Recently it has been introduced generally in America, through the Experiment Stations. Simultaneously other organic metallic salts have been developed and introduced in an experimental way.

Results secured in Europe and America show uspulun, the one longest established in the literature, to have a rather wide range of usefulness in plant pathology. It is an efficient disinfectant, with good penetration, so that it kills more than the merely superficial organisms. It does not, within a reasonable margin of the recommended strength or time of application, injure the seed. It protects seed from decay by soil organisms.

this protection extending even through the seedling stage, so that a better stand is secured. This is particularly the case where soft seed or seed of low germination is under consideration. Damping off of seedlings is often prevented by a seed treatment or a soil treatment about the young seedlings, or a combination of both. Some diseases such as brown-patch of lawns and golf greens have been efficiently controlled by application of uspulun. Results reported by various experimenters in America show without doubt that the organic salts of mercury are deserving of thorough consideration on the part of the plant patnologists in America.

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